12/15/2010

SAFE YIELD
STAFF REPORT

In the matter of

Wanaque Water System

Request for Reevaluation of the Wanaque Water System Safe Yield

In compliance with the provisions of N.J.S.A. 58:1A-1 et seq., and in accordance with N.J.A.C. 7:19-6.3, the North Jersey District Water Supply Commission (NJDWSC) filed a report with the Department of Environmental Protection on December 12, 2005 requesting approval of 208 million gallons per day (mgd) as the Wanaque Water System safe yield. The safe yield is derived from the existing Wanaque Water System, which utilizes the Wanaque and Monksville reservoirs along with the Two Bridges and Ramapo River pumping stations, located respectively on the Pompton River near the Pompton/Passaic confluence and on the Ramapo River at the Pompton Lake Dam. The requested safe yield of 208 mgd is 35 mgd above the previously approved safe yield of 173 mgd.

The safe yield of the Wanaque Water System represents an estimate of the amount of available water that can be reliably delivered by the system without cessation during conditions analogous to a repeat of the most severe drought of record, while maintaining established passing flows at several locations within the Passaic River Basin, and a no less reliable run-of-river source of water supply for users downstream of the confluence of the Passaic and Pompton Rivers. The most severe drought of record for the Wanaque Water System is the drought within the system's period of record that produces the least water supply yield for that system. The period of record is based on records of the surface water flow and storage gages that were used to compile and develop daily natural and reconstructed surface water flow data that are used to estimate the safe yield of the Wanaque Water System. The period of record of a water supply reservoir system should encompass the longest reasonable time period and, to the extent possible, be continuous. For New Jersey, the drought years 1929-1933, 1949-1951, 1961-1967, 1980-1983, 1984-1986, 1991-1996, 1998-2000, and 2001-2002 should be included to the extent possible. Based on data provided by the NJDWSC, the period of record of the Wanaque Water System extends back to October 1919. The safe yield estimate accounts for applicable regulatory restrictions, the purveyor's operating plans and physical limitations of the Wanaque Water System.

Background/Findings of Fact

1. A report dated September, 1911 and entitled "State Water-Supply Commission Report on The Development of a Water-Supply from the Wanaque River, with letters of transmittal" proposed two plans for developing the Wanaque watershed. These were intended to be worked out either concurrently or independently. One plan was the construction of a reservoir on the Wanaque River near Midvale, having an elevation of flow line of 275 feet above sea level, and a capacity of approximately 11 billion gallons. The other plan contemplated a high level supply from a point just below the outlet of Greenwood Lake where a small intake reservoir would be constructed far enough below the lake to obtain the advantage of the aeration of the waters which might be drawn from the lake. The report indicates that the reservoir, together with Greenwood Lake, would practically make

available the entire yield of the Wanaque River, being approximately from 75 mgd to 80 mgd. It should be noted that the concept of the yield of a river is different than the safe yield of a surface water supply reservoir system and may not consider passing flows, other regulatory restrictions, operating plans or physical limitations of any particular reservoir system.

2. On October 9, 1916, the NJDWSC filed a petition with the State of New Jersey, Board of Conservation and Development for the diversion of waters from the Wanaque River for proposed development of a water supply. The plans under consideration provided for construction of a storage reservoir on the Wanaque River at or near Midvale. The Board of Conservation and Development approved the application on December 19, 1916. On November 5, 1923, the NJDWSC applied to the State of New Jersey, Department of Conservation and Development for approval of its plans for diverting the waters of the Wanaque River and Post Brook to the maximum amount economically obtainable, in addition to the grant previously approved. The plans proposed to increase the height of the dam then being constructed at the Wanaque Reservoir, under the December 19, 1916 approval, to an elevation of about 300 feet above sea level and to develop a storage capacity of 27.6 billion gallons. NJDWSC's November 5, 1923 application (Water Supply Application No. 154) and the diversion of water from the Wanaque River and Post Brook as proposed therein were approved by the Board of Conservation and Development on January 16, 1924.

3. On December 9, 1949, the NJDWSC filed Water Supply Application No. 699 in the office of the State Water Policy Commission for approval of its plans to divert a new and additional source of water supply from the Ramapo River at the existing dam in the Borough of Pompton Lakes and pump the water through a 72-inch diameter force main 25,000 feet long to Wanaque Reservoir. In part, the application indicates that, at that time: existing records of rainfall and runoff of the Wanaque watershed at Wanaque, Passaic County, New Jersey, had demonstrated that the safe yield of the Wanaque Water System was 85 mgd; and the Wanaque system was obligated to furnish 100 mgd and could not deliver that amount. The application was approved, as therein modified, by the Water Policy and Supply Council on March 10, 1950. On January 7, 1958, the NJDWSC applied to the State of New Jersey, Department of Conservation and Development, Division of Water Policy and Supply for approval of a modification of Water Supply Application No. 699 for the Ramapo diversion. A pre-hearing order in this matter, adopted by the Water Policy and Supply Council on April 10, 1958, stipulates that the applicant requires a safe dependable yield of 110 mgd for public water supply purposes, and in calculating such safe dependable yield, a reserve storage of 25% should be provided. On November 13, 1958, the Water Policy and Supply Council adopted a resolution and order regarding the NJDWSC application for modification of Water Supply Application No. 699. In part, the resolution and order indicate that the 85 mgd yield obtainable from the natural watershed of the Wanaque River is based on the driest period of record, 1930 to 1932.

4. The November 13, 1958 resolution and order regarding the NJDWSC application for modification of Water Supply Application No. 699 indicates that the objective of the Ramapo diversion was to produce a dependable yield of 25 mgd in addition to the 85 mgd yield obtainable from the natural watershed of the Wanaque River. In order to achieve that objective of the Ramapo Diversion and result in an overall safe yield of 110 mgd for the Wanaque Water System, the 1958 resolution and order modified certain conditions of the March 10, 1950 approval. Following the November 13, 1958 resolution and order, the regulatory restrictions on the Ramapo diversion may be summarized as follows:

a. no diversion from the Ramapo River shall be made between June 1 and September 30 of any year and at no time when the net flow downstream from the point of diversion is less than forty million (40,000,000) gallons daily.

b. provision shall be made to increase the low flows below the point of diversion to a minimum of ten million (10,000,000) gallons daily and the water shall be released at or above the point of diversion as necessary to maintain said minimum flow; such release of compensation water shall not be required in excess of sixty (60) days in any calendar year.

c. The amount of water diverted from the Ramapo river for storage in Wanaque reservoir shall not exceed an average of 100,000,000 gallons daily during any calendar month, provided, however, that the withdrawal of said Ramapo water from storage in Wanaque reservoir shall not exceed an average of 25,000,000 gallons daily during any calendar year, except as may be necessary to provide compensation water as required herein.

5. In a letter dated October 4, 1963 from John Wilford of the State of New Jersey, Department of Health to the NJDWSC it is stated that: "According to the records of this Department the safe yield of water from your existing sources is 110 million gallons per day and your production records show that your present output is now very close to this figure".

6. On December 28, 1964, the Water Policy and Supply Council adopted a resolution pursuant to a hearing held December 28, 1964 for the NJDWSC to show cause why average draft from the Wanaque-Ramapo Reservoir system should not be reduced to less than 104 million gallons daily. In part, the resolution states the following: "BE IT RESOLVED, That the North Jersey District Water Supply Commission be, and hereby is, directed to proceed forthwith with negotiations with officials of other water supply systems to obtain, subject to Council approval, an interim supply of water adequate to reduce the draft on its Wanaque-Ramapo system to its current combined safe yield of 104 million gallons daily when the storage in Wanaque Reservoir is less than 50% of full capacity, until such time as facilities become available for the supply of water from the Spruce Run and Round Valley Reservoir System to meet the needs of the city of Bayonne and other systems now supplied in part or in full from the Wanaque-Ramapo system".

7. A February 15, 1967 memorandum from J. E. Malone and D. J. Kroeck, Supervising Engineers, to Robert E. Cyphers, Chief of the Bureau of Water Resources, indicates that it may be concluded that the drought of the 1960's is over and provides the results of analyses of the safe yields of six major surface water systems, including the NJDWSC Wanaque system. In part, the memorandum indicates that the safe yield of the Wanaque system was 110 mgd in 1962; 104 mgd as of December 16, 1964; 96 mgd as of February 11, 1966; 94 mgd as of September 30, 1966; and 94 mgd as of January 3, 1967. The memorandum also indicates that, for the Wanaque system, the 94 mgd safe yield is derived from 69 mgd natural inflow plus 25 mgd withdrawal from the Ramapo River diversion. The memorandum recognizes that the initial reduction from 110 to 104 mgd, for the Wanaque system, was by action of the Water Policy and Supply Council during December 1964 and recommends that the council adopt the lower safe yield of 94 mgd for Wanaque Reservoir.

8. A March 17, 1975 memorandum from Robert E. Cyphers, Chief of the Bureau of Water Supply Planning and Management, to the members of the Water Policy and Supply Council provides a summary of statements presented during and subsequent to the Council's public hearing on November 11, 1974. The summary of statements by Dean C. Noll of NJDWSC indicate, in part, that

the yield of 104 mgd for the Wanaque-Ramapo System established by Water Policy and Supply Council during the 1960's drought was being used as the basis of allocation to partners.

9. On August 11, 1975 the NJDWSC submitted an amended Water Supply Application No. 1651 and the Hackensack Water Company submitted an amended Water Supply Application No. 1685 to the New Jersey Department of Environmental Protection, Division of Water Resources. These were submitted as a joint application for approval of plans for additional surface water supply diversions from the Pompton and Passaic rivers, in the vicinity of their confluence, and from the Ramapo River at Pompton Lakes. These diversions, along with proposed facilities were designed to increase the safe yield of the Wanaque Water System. A part of amended Application No. 1651 signed by Dean C. Noll, Chief Engineer of NJDWSC, indicates that the capacity of the plant of the present water supply system at that time was 94 or 104 mgd (based on yield) and that the dry season yield of the proposed water supply system was 79 mgd. The combined total volumes of water to be diverted under the joint application, including existing and additional diversions, included a monthly maximum of 250 mgd from the Pompton and Passaic rivers at the Two Bridges location from stream flows in excess of 92.6 mgd and a monthly maximum of 150 mgd from the Ramapo River at Pompton Lakes from stream flows in excess of 40 mgd. The joint application requested that pumping be permitted during all months and that the limitation previously imposed on NJDWSC withdrawals of Ramapo water from storage in Wanaque Reservoir be eliminated.

10. At a meeting held Monday, September 25, 1978, the Water Policy and Supply Council made a decision and order in the matter of the NJDWSC Water Supply Application No. 1651 and Hackensack Water Company Water Supply Application No. 1685. In part, the decision and order indicate the following:

    a. The project presented by the NJDWSC and the Hackensack Water Company is to be considered a joint project and referred to as the Two Bridges/Ramapo Diversion Project.

    b. The applications as requested would develop about 79 mgd increase in safe yield of the Wanaque Reservoir.

    c. The State concluded that the Round Valley water for use in the Passaic Basin will be a future consideration.

    d. In an alternative considered by the State Division of Water Resources by invoking the rule of no summer pumping between June 1 and September 30 at both the Two Bridges and Ramapo pumping stations, it was found that a decrease in yield from 79 to 64 mgd would result. However, by constructing the 7 billion gallon Monksville Reservoir upstream from the Wanaque Reservoir and by keeping 2.8 billion gallons of storage in reserve, 79 mgd could still be developed by the project.

    e. The applicants request in their application that the rule of no summer pumping (June 1 - September 30) not be invoked in an approval thereof. In considering this alternative it was found that a decrease in yield of the proposed project from 79 to 64 mgd would result. There is a possibility that the pumping restrictions on the basis of temperature would prevent summer pumping at Two Bridges, which could have an impact on the yield of the project. A redeeming circumstance that would offset the above situation is the construction of the proposed 7 billion gallon Monksville Reservoir, by keeping 2.8 billion gallon of storage in reserve, the 79 mgd

could still be developed. It is therefore deemed that the rule of no summer pumping between July 1 and August 31 should be invoked and, if the project yield shows that the yield of 79 mgd cannot be achieved thereunder, it is recommended that the proposed Monksville Reservoir be built.

f. The applications are approved as modified herein, subject to limitations, terms and conditions.

g. No diversion from the Ramapo River or the Pompton-Passaic rivers shall be made by NJDWSC and/or the Hackensack Water Company between July 1 and August 31 of any year. Furthermore, if the applicants find that the project yield of 79 mgd cannot be achieved hereunder, the proposed Monksville Reservoir may be constructed, pursuant to NJSA 58:4-1, et seq.

h. Pumping of water from the Ramapo River and from Two Bridges was made subject to water quality conditions, including dissolved oxygen and temperature.

i. There shall be no diversion of water from the Ramapo River when stream flows are below 40 mgd. There shall be no diversion by NJDWSC or Hackensack Water Company from the Two Bridges pumping station which reduces stream flow in the Passaic River below its confluence with the Pompton River under 92.6 mgd.

11. On February 23, 1979, Daniel J. O'Hern, then Commissioner of the New Jersey Department of Environmental Protection, issued an order approving the action of the Water Policy and Supply Council and also permitting encroachment of an historic site in the matter of the amended water supply application Nos. 1651 and 1685 of the NJDWSC and the Hackensack Water Company. In part, the order states the following: "If the project as approved does not provide the 79 mgd safe yield projected, the Water Policy and Supply Council has approved the original Monksville Reservoir application which should provide an additional 25 mgd safe yield. I likewise approve this aspect of the Council's action, but it is hoped that this unique joint venture of a public and private water supplier with a projected capital investment of at least $50,000,000 will satisfy the region's water supply needs.

12. A June 1985 report entitled "Influence of Wanaque South Project on the Temperature and Dissolved Oxygen Regimes of the Pompton and Passaic Rivers" by Tavit O. Najarian and Vajira K. Gunawardana and prepared for NJDWSC and Hackensack Water Company indicates, in part, that in its early stages of development, the Wanaque South Project was known as the Two Bridges Project but that the latter designation was dropped after 1981.

13. The current Wanaque Water System utilizes water from sources that may be organized into three categories as follows:

a. The tributary system that drains by gravity to the Wanaque Reservoir and Monksville Reservoir, including the natural drainage area up-gradient of the reservoirs and the drainage area up-gradient of the Post Brook Diversion. The drainage area above the Wanaque Reservoir is estimated to be approximately 90.4 square miles and includes the drainage area of the Monksville Reservoir. The drainage area of the Monksville Reservoir alone is estimated to be approximately 40.4 square miles. The Wanaque River flows from Greenwood Lake into Monksville Reservoir. Spills and releases from Monksville Reservoir flow directly into the

Wanaque Reservoir. The Ringwood Creek and several smaller streams also flow directly into the Wanaque Reservoir and some of the flows from Post Brook are diverted into the Wanaque Reservoir. A dam on Post Brook elevates the water levels to the point that it flows via gravity into the Wanaque Reservoir. The natural drainage area up-gradient of the reservoirs includes areas within New York State.

b. The tributary system that drains to the Ramapo Intake and the Ramapo River Pump Station (RRPS) located on the Ramapo River at the Pompton Lake Dam, with an upstream drainage area that is estimated to be approximately 160 square miles; and

c. The tributary system that drains to the Two Bridges Intake and the Two Bridges Pump Station (TBPS) located approximately 1,000 feet upstream from the confluence of the Pompton and Passaic rivers. By design, when the diversion from the Two Bridges Intake exceeds the available flow in the Pompton River, such diversion reverses flow in the lowermost reach of the Pompton River and draws in the flow from the Passaic River. In this way, at times, the tributary system of the total drainage area of the Pompton and Passaic rivers at their confluence becomes a contributing source to the Two Bridges Intake and the TBPS. The total drainage area of the Pompton and Passaic rivers at their confluence is estimated to be approximately 741 square miles. Based on NJDEP Geographic Information System (GIS) data, the drainage area of the Passaic River above its confluence with the Pompton River is approximately 361 square miles. By subtraction, the drainage area of the Pompton River above its confluence with the Passaic River is approximately 380 square miles. The drainage area of the Pompton River includes the drainage area upstream of the RRPS as well as the drainage area of tributary system that drains to the Wanaque and Monksville reservoirs by gravity.

14. The Wanaque Water System facilities have the following capacities:

a. The Wanaque Reservoir has a total storage capacity of approximately 29.6 billion gallons (bg) and the Monksville Reservoir has a total storage capacity of approximately 7.0 bg, for a combined total storage capacity of approximately 36.6 bg. In addition to the gravity inflow from the Wanaque River, Post Brook and other streams as noted above, the Wanaque Reservoir can be augmented by pumping from the RRPS and the TBPS as noted below. Water from the Wanaque Reservoir is either diverted into a 210 mgd treatment plant via an 84-inch intake at a maximum rate of 514 mgd, or transferred to the Oradell Reservoir. Water transfers to the Oradell Reservoir are first conveyed via gravity through the same 72-inch diameter force main utilized to pump water to the reservoir from the RRPS. At Pompton Junction, on the 72-inch diameter force main, United Water New Jersey (UWNJ) can divert water from the force main to the Pompton Lakes Pump Station (PLPS), which pumps the water to the Oradell Reservoir.

b. Water at the RRPS is diverted from an intake located on the upstream side of the Pompton Lake Dam. Water from the lake flows by gravity into a dual intake structure, through a screen house into the pump house. Water allocation permit number 5274, with an effective date of October 1, 2006, provides that water can be diverted from the Ramapo River at the RRPS at a maximum permitted rate of 4,650 million gallons per month (mgm), at an average permitted daily rate of 150 mgd (37.5 mgd average per pump). The staff report for permit number 5274 indicates that the RRPS has four 50 mgd pumps that are maintained and operated by NJDWSC. A July 2010 NJDWSC report on proposed RRPS intake modifications indicates that the RRPS presently has four horizontal split case centrifugal pumps, each of equal size and capacity, and that the design

point of each pump is 37.5 mgd at 142 feet of total dynamic head. Water is diverted into a 72-inch diameter force main which flows to the Wanaque Reservoir.

c. Water at the TBPS flows from the Pompton and Passaic rivers through a concrete channel to trash racks and a traveling screen to four individual wet wells where there are eight individual pump intakes. Two pumps share a wet well, and all pumps are equipped with low suction shut off devices. In the pump house, six 50 mgd pumps are maintained and operated by NJDWSC for the Wanaque Water System under permit number 5094, and two 50 mgd pumps are maintained and operated by Passaic Valley Water Commission (PVWC) under permit number 5099, to divert water to their systems. The PVWC diverts water from the TBPS directly to its water treatment plant at Little Falls about 4 miles downstream of TBPS, where it maintains another intake on the Passaic River. The Wanaque Water System's pumps divert water at a maximum permitted rate of 7,750 mgm, at an average permitted daily rate of 250 mgd (41.7 mgd average per pump), into a 102-inch diameter concrete force main which flows to the Wanaque Reservoir. Near Pompton Junction, on the 102-inch diameter force main, UWNJ can divert water from the force main to the PLPS, which pumps the water to the Oradell Reservoir.

15. The Wanaque Water System safe yield is based on effective water allocation permits issued by the Department of Environmental Protection that grant the privilege to divert water from approved sources as follows:

Permit No.	Date Issued	Source of Water	Diversion Amount
5094	9/07/06	Pompton and Passaic Rivers	7,750 mgm
5274	9/07/06	Ramapo River @ Pompton Lakes	4,650 mgm
5329	9/07/06	Wanaque River and Post Brook	514 mgd

16. The Wanaque Water System safe yield is based on conjunctively utilizing the following storage facilities and sources:

No.	Source	Capacity	Passing Flow
1	Monksville Reservoir	7.0 bg total storage	None (Operated conjunctively w/Wanaque Reservoir)
2	Wanaque Reservoir	29.6 bg total storage	10 mgd * (15.47 cfs)
3	RRPS	4,650 mgm @ avg daily rate of 150 mgd	40 mgd (61.9 cfs)

No.	Source	Capacity	Passing Flow
4	TBPS	7,750 mgm @ avg daily rate of 250 mgd	92.6 mgd (143.3 cfs)
5	Post Brook	All water in excess of the passing flow	0.35 mgd (0.54 cfs)

* -unless Greenwood Lake flow is less than 3 mgd (4.64 cfs) then passing flow reverts to 7 mgd (10.83 cfs).

17. NJDWSC ensures water is available from the Wanaque Water System for its Wanaque South partner, UWNJ, and its contracting Wanaque South and Wanaque North municipalities.

a. Wanaque North Amounts:

Town	Contracted Amount (mgd)
City of Newark	38.070
Passaic Valley Water Commission	35.485
Paterson	18.800
Passaic	10.340
Clifton	6.345
Kearny	11.280
Montclair	4.700
Bloomfield	3.760
Glen Ridge	0.705

b. Wanaque South Amounts:

Town	Contracted Amount (mgd)
United Water New Jersey*	39.5
City of Newark	11.33
City of Bayonne	10.50
Town of Kearny	1.72
Township of Bloomfield	2.75
Township of Cedar Grove	1.20
Town of Nutley	3.00
Wayne	9.00

* - UWNJ is a 50% owner of the Wanaque South Project.

18. A review of quarterly diversion reports indicates the following:

a. diversion from the RRPS:

Year	Annual Use (mgy)	Max Month Use (mgm)	Average Monthly Use (mgm)**	Existing Allocation (mgm)
2009	0	0	0	4650
2008	0	0	0	4650
2007	2,431.7	1,345.8	810.567	4650
2006	1,023.4	1023.4	1023.4(1)	4650
2005	0	0	0	4650
2004	0	0	0	4650
2003	0	0	0	4650
2002	13,911.9	2,918.5	1,545.8 (9)	4650
2001	0	0	0	4650
2000	0	0	0	4650

b. diversion from the TBPS:

Year	Annual Use (mgy)	Max Month Use (mgm)	Average Monthly Use (mgm)**	Existing Allocation (mgm)
2009	2,033.0	2,033.0	2,033.0 (1)	7,750
2008	6,211.0	2,482	2,070.3 (3)	7,750
2007	10,364.2	3,717	2,073.04 (5)	7,750
2006	2,455.3	2,008.8	1,227.7(2)	7,750
2005	1,816.1	1,131.1	908.1(2)	7,750
2004	313.8	313.8	313.8 (1)	7,750
2003	241.3	241.3	241.3 (1)	7,750
2002	30,215.5	6,047.8	3,021.6 (10)	7,750
2001	15,205.1	3,663.8	1,689.5 (9)	7,750
2000	7,407.2	3,269.9	1,481.4 (5)	7,750

** (#) indicates the number of months the pump station was in operation during the year indicated.

c. diversion from the Wanaque Reservoir:

Year	Annual Use (mgy)	Max Month Use (mgm)*	Average Monthly Use (mgm)	Existing Allocation (mgd)
2009	36,758.422	3,485.813 (Dec)	3,063.202	514
2008	36,945.610	3,263.689 (Jul)	3,078.801	514
2007	39,161.661	3,504.925 (Oct)	3,263.472	514
2006	38,945.677	3,476.055(Mar)	3,245.473	514
2005	38,451.139	3,445.629(Apr)	3,204.332	514
2004	37,075.447	3,396.665(Jan)	3,089.621	514
2003	39,905.978	3,715.318(Jan)	3,325.498	514
2002	36,089.999	3,603.832(Aug)	3,007.499	514
2001	40,047.660	3,805.502(Aug)	3,337.305	514
2000	40,008.208	3,592.388(July)	3,334.017	514

* indicates the month in which the maximum monthly use occurred during the year indicated.

19. A review of quarterly diversion reports from 2000 to 2009, which includes the period from November of 2001 until September of 2002 during a severe drought event, indicated the following water sent to UWNJ from the Two Bridges and Ramapo Pump Stations and/or from the Wanaque Reservoir:

Year	Annual (mgy)	Max Month (mgm)*	Average Month (mgm)**
2009	863.707	863.707 (Oct)	863.707 (1)
2008	1,795.728	1,112.605 (Jul)	448.932 (4)
2007	6,669.483	1,335.180 (Sept)	952.783 (7)
2006	1,848.385	693.139(Aug)	308.064(6)
2005	4,755.139	1,379.270(Sept)	679.306(7)
2004	1,465.675	342.754(Oct)	209.382(7)
2003	979.217	217.000(July/Aug)	195.843(5)
2002	4,103.768	1,258.683(Aug)	410.377(10)
2001	8,463.693	1,329.188(Aug)	769.427(11)
2000	2,273.617	920.382(July)	324.802(7)

* indicates the month in which the maximum monthly use occurred during the year indicated.
** (#) indicates the number of months the pump station was in operation during the year indicated.

20. The Wanaque Water System's diversion sources are located within: New Jersey Water Supply Planning Area 4, Upper Passaic Pompton/Ramapo River as designated by the New Jersey State Water Supply Master Plan; Metropolitan Planning Area PA-1, and an Environmentally Sensitive Planning Area PA-5 as designated by the New Jersey State Development and Redevelopment Plan; the Northeast Drought Region; and the Pompton, Wanaque, and Ramapo Watershed Management Area. The Passing Flow requirement for the Two Bridges Pump diversion is regulated relative to the Little Falls Gage located on the Passaic River in New Jersey Water Supply Planning Area 5. The Wanaque Reservoir, the Monksville Reservoir, and the Post Brook diversion are located within the Highlands Preservation Area.

21. Completed in 1987, the TBPS was constructed under the Wanaque South Project as a joint venture between NJDWSC and UWNJ (at the time the former Hackensack Water Company). It was developed to serve their respective customers, and included improvements at the Ramapo River Pump Station and construction of the dam that forms the Monksville Reservoir. UWNJ is a 50% partner (25 mgd each)in the expansion of the RRPS from 100 mgd to 150 mgd, and a 50% partner in the 250 mgd permitted capacity of the TBPS for the Wanaque South Partnership. NJDWSC operates the TBPS and RRPS and diverts both NJDWSC's and UWNJ's allocation of the Wanaque South Project either directly from the TBPS or RRPS. Water from either pump station or from the Wanaque Reservoir can be transferred to the UWNJ System through the Pompton Junction and the PLPS.

22. The PVWC operates the Jackson Avenue Pump Station (JPS) and its intake (permit Number 5395) on the Pompton River downstream of the Pequannock River confluence and approximately 5 miles upstream of the TBPS. The JPS is equipped with five, 10 mgd capacity pumps, and is permitted to divert up to 1,550 mgm (50 mgd average). The JPS is used to fill Point View Reservoir (PVR), which is a man-made facility with a storage capacity of approximately 2.8 billion gallons. The PVR is utilized to augment flow in the Pompton River to help ensure that 75 mgd is available to PVWC at the Two Bridges Intake and at PVWC's Little Falls Intake and treatment plant. If NJDWSC is not utilizing the 102-inch diameter force main which runs from TBPS to the Wanaque Reservoir, NJDWSC may allow PVWC to make use of that force main so that water can also be diverted from Point View Reservoir directly into the 102-inch force main and flow by gravity to the TBPS where PVWC can pump it to their treatment plant.

23. The conditions of the Wanaque South Agreement are a separate set of contract conditions, not regulated by a water allocation permit.

24. The majority of finished water supplied by the Wanaque Water System, after use, is conveyed to various regional wastewater treatment plants for treatment and discharge to the Passaic River watershed downstream of the Ramapo and Two Bridges diversions.

25. Monksville Reservoir's water quality classification is FW2-TM (C1). The Monksville Reservoir receives no direct augmentation from either the TBPS or the RRPS and depends entirely on gravity inflow from the Wanaque River watershed. The Wanaque Reservoir is supplemented by releases from the Monksville Reservoir immediately upstream but also receives augmentation from the TBPS and the RRPS, and inflow from the surrounding drainage area including Post Brook. The Wanaque Reservoir's water quality classification is FW2-TM(C1). At the RRPS, the Ramapo River's water quality classification is FW2-NT(C2). At the TBPS, the water quality classification is FW2-NT(C2).

26. The nearest wastewater discharge to the RRPS is from the DuPont Specialty Chemicals Company Wastewater Treatment Plant in the amount of 0.61 mgd, located approximately 2 miles upstream on the Ramapo River. The nearest wastewater discharge to the TBPS is from the Two Bridges Sewer Authority Treatment Plant in the amount of 4.98 mgd, located approximately 1000 feet upstream on the Pompton River. These wastewater discharge quantities are from a United States Geological Survey report (USGS, 2001) and are based on 1993 through 1996 data.

27. The Monksville Reservoir is on the Wanaque River just above the Wanaque Reservoir, also on the Wanaque River. Both reservoirs are situated principally in Ringwood Borough in Passaic County. Portions of Wanaque Reservoir are also located in Wanaque and Bloomingdale Boroughs, also in Passaic County, and a portion of the Monksville Reservoir is located in West Milford Township, Passaic County. The following is a table of the Reservoirs' physical characteristics:

Reservoir Characteristic	Monksville Reservoir	Wanaque Reservoir
Spillway elevation (feet, ngvd)	400	302.4
Capacity (bg)	7.0	29.63
Pool area (acres)	504	2,310
Width at widest point (mi.)	0.6	1.2
Length (mi.)	2.9	6.6
Average width (mi.)	0.2	0.5
Greatest depth (ft)	95	90
Average depth (ft)	43	37
Watershed area (sq.mi.)	40.4	90.4

28. Minimum passing flow requirements for the diversions have been established as follows:

a. No diversion shall occur from the RRPS when the stream flow at the Ramapo River at Pompton Lakes USGS stream gage (#01388000) falls below 61.88 cfs (40 mgd). In 2004 a new weir was constructed when the gage was moved from the dam to a site 400 feet downstream due to modification of the Pompton Lake Dam.

b. No diversion for the Wanaque Water System shall occur from the TBPS when the stream flow at the confluence of the Pompton and Passaic Rivers falls below 143.3 cfs 92.6 mgd) assuming PVWC is diverting its full 75 mgd allocation at the Little Falls intake or 27.2 cfs (17.6 mgd) when PVWC is diverting from the TBPS. There is no flow gage located at TBPS. The NJDWSC TBPS passing flow is taken at the USGS flow gage located below PVWC's Little Falls intake (#01389500). The NJDWSC TBPS passing flow is calculated at Two Bridges by adding the actual flow measured by the gage to the diversion amount by PVWC at Two Bridges and Little Falls, if any. If the NJDWSC passing flow at Two Bridges falls below 143.3 cfs, and PVWC is not diverting their entire 75 mgd allocation from Two Bridges and/or Little Falls, then diversions for the Wanaque Water System would be allowed to include the difference of flows between the actual diversion by PVWC and their allocation of 75 mgd, after passing 27.2 cfs at

Little Falls. NJDWSC should notify PVWC of their intent to operate the Wanaque Water System to divert any of PVWC's unused allocation below the Two Bridges passing flow of 143.3 cfs.

c. No diversion shall occur from Post Brook when the stream flow below the dam falls below 0.54 cfs (0.35 mgd). This is controlled by several 8-inch diameter pipes in the bottom of the dam that allow the required flow to pass.

d. The minimum Wanaque River flow measured below the Raymond Dam shall be maintained at 15.47 cfs (10 mgd) if the quantity of water discharged from Greenwood Lake is 4.64 cfs(3 mgd) or greater. If the quantity of water discharged from Greenwood Lake falls below 4.64 cfs (3 mgd) then the minimum reservoir release shall be maintained at 10.83 cfs (7 mgd) below Raymond Dam.

29. Management of the in-stream diversions and on-stream reservoir storage, including pumped-storage, allows the Wanaque Water System to substantially regulate in-stream flows. During periods of low natural stream flows, the passing flow requirements at the RRPS and TBPS locations in conjunction with the passing flow requirement at the Raymond Dam assures that Wanaque Water System diversions do not reduce the availability of flow for diversion by PVWC. By utilizing various sources, it is ensured that water is available to meet public water supply needs of water supply purveyors downstream of the RRPS and TBPS.

30. The proposed safe yield estimate report submitted by NJDWSC in 2005, along with the Wanaque Reservoir Safe Yield and Two Bridges – Ramapo Diversion Simulation Model (Wanaque Model)for the period October 1919 through December 2003, several follow up letters, reports, and meetings provided information pertaining to a previous safe yield estimate (NJIT 1984), and a new safe yield estimate. In response to a July 1, 2008 letter from the Department of Environmental Protection, NJDWSC also submitted a separate Microsoft Excel spreadsheet model that is focused on estimating the sustainable supply of the Wanaque Water System during the 2001-2002 drought. The term "sustainable supply" as used here has a meaning similar to safe yield except that it is based on only a portion of the Wanaque Water System's period of record rather than the entire period of record. The information submitted by NJDWSC had differences from that pertaining to the previous safe yield estimate with regard to: daily reconstructed surface water flow data that cover an additional time period from 1981 through 2003, wastewater discharge volumes, model assumptions and operations criteria, system demands and demand patterns.

31. The Wanaque Water System components are the same water sources utilized for a previously estimated safe yield of 177 mgd (NJIT, 1984). It should be noted that a safe yield of 173 mgd was previously approved for the system by the Department of Environmental Protection and remains in effect. However, for the purposes of this report the safe yield of 177 mgd as estimated by the 1984 NJIT Study is referred to because it included documentation and methods that enabled a comparative analysis with the results of the Wanaque Model. Several significant changes have occurred in the water supply system since the 1984 estimate. The first is that water quality for dissolved oxygen in the rivers has improved to the extent that it can be assumed whenever stream flows exceed the minimum passing flow, pumping may occur in May, June and September (see item 34 of the Staff Analysis and Conclusions section below). The NJIT safe yield model had limited diversions at the TBPS in these months to only that flow exceeding approximately 500 cfs (323 mgd), predicated on the probability that water allocation permit limits for dissolved oxygen would prevent diversions at

flows lower than about 500 cfs. Removal of this model restriction extends the available pumping from the equivalent of about 7 months during dry years to 10 months per year. The second significant development is an increase in treated wastewater discharges from about 44 mgd used in the 1984 NJIT safe yield estimate to about 67 mgd being discharged during the period 1993 to 1996, which augments the stream flow. The 1993 to 1996 wastewater discharges are taken from the averages used in a 2001 USGS report in the Passaic River watershed (although the Wanaque Model allows for other discharge scenarios). Not only does the Wanaque Model assume that the additional treated wastewater is augmenting flow, but the model is now utilizing the flow an additional 3 months every year due to improved water quality as noted above and in item 34 of the Staff Analysis and Conclusions section. The safe yield of the Wanaque Water System is based upon the most severe drought of record. The third significant change is that the period of record for the hydrological database from which the most severe drought of record is determined has been extended. The 1984 NJIT estimate of safe yield was based on a hydrological database for a sixty year period of record from 1921 through 1981. The Wanaque Model extended this period of record for the hydrological database forward for approximately 22 additional years, from 1981 through 2003.

32. The peak month to average annual use ratio used in the 1984 analysis according to Drs. Pen Tao (NJDWSC) and Gene Golub (contributing author to the 1984 NJIT Study) was about 1.2 to 1. There is no significant change to this use ratio in the current assessment. A unit demand pattern was generated based on recent typical usage and the trial safe yields used this pattern in order to mimic seasonal uses. Safe yield is normally expressed as a continuous annual average demand.

33. The operational rules utilized for the Wanaque Water System safe yield re-evaluation are as follows:

    a. Water is released from Monksville to Wanaque Reservoir as needed when Wanaque Reservoir storage falls below 8 bg. Wanaque Reservoir must maintain a minimum release of 10 mgd. Augmentation pumping to Wanaque Reservoir may be either from the RRPS, TBPS, or both pump stations.

    b. Pumping from the RRPS may commence whenever the passing flow can be maintained at 40 mgd or greater, except during July and August when no pumping is allowed, and:

        i. In addition to the passing flow of 40 mgd, the Wanaque Model assumes that the minimum capacity of the RRPS is about 15 mgd, so that 55 mgd must be available to enable pumping,

        ii. The average 24-hour dissolved oxygen (DO) level is maintained at 5.0 milligrams per liter (mg/l),

        iii. There is no depression of DO below 4.0 mg/l due to the diversion; however, the diversion shall be permitted when DO is naturally below 4.0 mg/l,

        iv. No diversion can be made if it causes a temperature increase when the streams are already at 30 degrees Celsius or higher, and

        v. No diversion is allowed if it were to cause the water temperature to increase by more than 2.8 degrees Celsius.

c. Pumping at the TBPS may commence whenever the passing flow can be maintained at 92.6 mgd or greater, except in July and August when no pumping is allowed, and:

i. In addition to the passing flow of 92.6 mgd, the Wanaque Model assumes that the minimum pumping rate is 30 mgd via the TBPS variable speed pumps, so that 122.6 mgd must be available to enable diversion,

ii. The average 24-hour DO level is maintained at 5.0 mg/l,

iii. No diversion can be made if it causes a temperature increase when the streams are already at 30 degrees Celsius or higher, and

iv. No diversion is allowed if it were to cause the water temperature to increase by more than 2.8 degrees Celsius.

d. The maximum pumping per month at the TBPS is 7750 mg (3,875 mg based on NJDWSC's allocation and 3,875 mg based on UWNJ's allocation).

e. The maximum pumping per month at the RRPS is 4,650 mg (3,875 mg based on NJDWSC's allocation and 775 mg based on UWNJ's allocation).

34. When stream flow quantities are sufficient, and when diversion criteria allow, diversion can occur from the TBPS and/or the RRPS directly to the Wanaque Reservoir when there is enough storage volume available in the reservoir. The NJDWSC Wanaque Model, as submitted, uses a simulated volume of 27.5 bg of water stored in the Wanaque Reservoir as an operational trigger to determine when diversions may be simulated to occur at both the TBPS and the RRPS. The NJDWSC Excel spreadsheet model, as submitted, does not limit simulated diversions at the TBPS and the RRPS based on the simulated volume of water being stored in the Wanaque Reservoir. From the Wanaque Reservoir, water can be conveyed to NJDWSC's water treatment plant for treatment and distribution, and raw water can be transferred to UWNJ's Oradell Reservoir (see 14 above), as needed and as allowed by design and contract.

35. The augmenting effect of treated wastewater discharges were considered by NJDWSC in the Wanaque Model. The discharges were added as average annual rates to the daily reconstructed surface water flow data in the model. Several regional public wastewater treatment plants, many smaller plants and several commercial plants throughout the Passaic Basin contribute up to, on average, about 67 mgd to the stream flows above the RRPS and/or TBPS, that either directly augment flows available for diversion or help augment passing flows. At the time the 177 mgd safe yield estimate was made in 1984, approximately 44 mgd of wastewater treatment plant discharges were considered. The following is a list of the wastewater treatment plants considered in the current safe yield estimate:

No.	Wastewater Treatment Plant	Average Daily Discharge (mgd)	Watershed (starting from furthest upstream plant)
1	Woodland STP	1.31	Passaic River
2	Chatham TWP Main STP	0.72	Passaic River
3	Harrison Brook STP	1.88	Passaic River
4	Long Hill TWP STP	0.74	Passaic River
5	Reheis Chemical Co	0.74	Passaic River
6	Berkeley Heights WPCP	1.48	Passaic River
7	New Providence WWTP	0.44	Passaic River
8	Novartis Pharmacy WWTP	0.52	Passaic River
9	Molitor WPC	3.27	Passaic River
10	Florham Park STP	0.92	Passaic River
11	Livingston TWP STP	3.42	Passaic River
12	Caldwell WWTP	3.79	Passaic River
13	Wayne TWP Mountainview WWTP	7.04	Passaic River
14	Butterworth STP	1.67	Whippany River
15	Morristown STP	2.00	Whippany River
16	Hanover SA	2.21	Whippany River
17	Par-Troy Hills	12.29	Whippany River
18	US Army	0.63	Rockaway River
19	Rockaway Valley Regional SA	9.35	Rockaway River
20	Orange County SA (NY)	4.12	Ramapo River
21	Suffern STP (NY)	1.60	Ramapo River
22	DuPont Specialty Chemicals	0.61	Ramapo River
23	Pompton Lakes Borough	0.84	Ramapo River
24	Wanaque Valley Regional SA	0.90	Wanaque River
25	Two Bridges SA	4.98	Pompton River
	Total	67.47	

Of the 67.47 mgd of treated wastewater discharge: a) 13.05 mgd (about 20%) is discharged above the TBPS on the Pompton River, b) 47.38 mgd (about 70%) is discharged to the Passaic River

upstream of the Pompton River confluence, and c) the remaining 7.04 mgd (about 10%) is discharged to the Passaic River below the Pompton River confluence.

Staff Analysis and Conclusions

1. On December 28, 1964, during the middle of the 1960's drought, the Water Policy and Supply Council adopted a resolution that indicates the safe yield of the Wanaque-Ramapo system at that time was 104 mgd. Analyses by the State documented in a February 15, 1967 memorandum indicate that the safe yield of the NJDWSC Wanaque system was reduced from 110 mgd to 94 mgd as a result of the 1960's drought. It does not appear that the lower safe yield of 94 mgd was ever adopted by the Water Policy and Supply Council.

2. NJDWSC's part of the joint application with Hackensack Water Company in 1975 indicates that the safe yield of the NJDWSC Wanaque system at that time was either 94 or 104 mgd and that the safe yield of the proposed additional diversions was 79 mgd. The joint application was approved with modifications including diversion restrictions at both the RRPS and the TBPS that reduced the safe yield. The diversion restrictions included no diversions between July 1 and August 31 of any year as well as water quality restrictions that precluded a specific determination regarding the times that diversions were allowed and the magnitude of reduction in safe yield at the time of the approval. The approval indicated that if the project yield of 79 mgd cannot be achieved, the proposed Monksville Reservoir may be constructed. The February 23, 1979 Commissioner's Order indicated that the original Monksville Reservoir application should provide an additional 25 mgd of safe yield. However, the original August 1, 1973 Monksville Reservoir application and the additional 25 mgd of safe yield were based, in part, on an increase in maximum monthly Ramapo River diversion privileges at Pompton Lake from 100 mgd to 150 mgd. Because a similar increase in diversion privileges was already a part of the joint application, the additional safe yield from construction of the Monksville Reservoir appears to be less than 25 mgd. A November 29, 1972 Preliminary Engineering Report for the Monksville Project prepared by the NJDWSC and signed by NJDWSC's Chief Engineer, Dean C. Noll, indicates that creating additional storage without augmenting the inflow would not produce any meaningful increase in the dependable yield of the system.

3. A report entitled "Safe Yield Study of Proposed Projects to Provide Additional Water for Northeast New Jersey" by Robert Dresnack, Eugene Golub and Franklin Salek of the Department of Civil and Environmental Engineering at NJIT, dated July 1984, developed a safe yield analysis of various water supply alternatives for northeast New Jersey. In part, the report indicates that the NJDWSC Wanaque System safe yield with the Wanaque South Project operational would be 177 mgd and the drought of record would be the multi-year 60's drought. Without the Monksville Reservoir, the report indicates that the safe yield would be 152 mgd and the drought of record would be the one year drought in 1941. A March 1988 report entitled "Influence of Wanaque South Diversion on the Trophic Level of Wanaque Reservoir and its Water Quality Management Program" by Po-Shu Huang, Tavit O. Najarian and Vajira K. Gunawardana and prepared for NJDWSC and Hackensack Water Company indicates, in part, the following: "The Wanaque Reservoir has a posted safe yield of 94 million gallons a day (mgd). The system currently serves several northern New Jersey communities with a total population of approximately 700,000. The ultimate safe yield of the system will rise to 173 mgd when all elements of the Wanaque South project become fully operational."

4. As indicated above, there was uncertainty regarding the safe yield of the Wanaque Water System following approval of the Wanaque South Project. Additional estimates of the safe yield were prepared following project approval but none of the estimates have been approved by the Department of Environmental Protection. The Department of Environmental Protection generally limits actual water demands on individual surface water supply reservoir systems regulated under the Water Supply Management Act to the approved safe yield estimate for the system by: limiting system diversions through conditions in applicable water allocation permits; and/or by limiting contractual obligations of applicable water allocation permit tee's through review and approval of the contracts. The Department of Environmental Protection has allowed NJDWSC to contract for 173 mgd of water supply from the Wanaque Water System. The contract amount of 173 mgd appears to be based on the State safe yield estimate of 94 mgd at the end of the 1960's drought plus the safe yield estimate of 79 mgd from the August 11, 1975 joint application by the NJDWSC and Hackensack Water Company. The joint application was approved by the Department of Environmental Protection and contained not only the safe yield estimate of 79 mgd for the proposed additional diversions, but also indicated that the safe yield of the NJDWSC Wanaque system at the time of the application was either 94 or 104 mgd. The yield of 104 mgd was being used as the basis of allocation to partners, in other words to set contract amounts, probably because NJDWSC was already obligated by contracts to provide that amount and because that level of demand already existed at that time. There are obvious difficulties associated with reducing contract amounts when the demand already exists. After approval of the 1975 joint application and construction of the Wanaque South Project, the Wanaque Water System contracts and demand were no longer greater than the system safe yield, so it was logical to add the safe yield estimate of 94 mgd (rather than 104 mgd) to the safe yield estimate of 79 mgd for the proposed additional diversions to calculate an approved safe yield of 173 mgd for the Wanaque Water System.

5. Dead storage, the amount of the storage not usable and/or accessible for water supply, has been estimated by the NJDWSC to be 0.142 bg in the Wanaque Reservoir and 0.140 bg in the Monksville Reservoir, for a total of 0.282 bg. For the Wanaque Reservoir, the estimate is based on an analysis of the bathymetry of the reservoir using topographic mapping that was created prior to the construction of the reservoir and the lowest intake elevation of 222 feet above mean sea level. The topographic mapping for the area of the Monksville Reservoir prior to construction was not detailed enough to effectively model the reservoir's bathymetry. Therefore, the area-capacity curves of the Monksville Reservoir and the lowest intake elevation of 314.5 feet above mean sea level were used to estimate the dead storage.

6. The Wanaque Model was developed principally by Dr. Pen Tao of the NJDWSC and was originally created, in decades past, using the FORTRAN programming language. New, updated, forms of the model that can be run on Microsoft Windows operating systems and that allow access to the FORTRAN code were submitted to the Department of Environmental Protection for the current evaluation of the safe yield. This permitted the Department to run alternative average annual demands and to examine the model structure and many of the model assumptions and calculations. The Department substantiated that many of NJDWSC's Wanaque Model assumptions used for the 208 mgd safe yield estimate are similar to those used for the 1984 NJIT safe yield study. One method of validation of NJDWSC's Wanaque Model is by comparison with the outcome of the previous NJIT Study. The Department found that the safe yield estimated by the 1984 NJIT Study, 177 mgd, is approximately replicated by the NJDWSC's Wanaque Model, after adjusting for increased availability of water due to improvements in water quality and increases in treated wastewater discharge volumes that have occurred since the previous study and assuming that there is

no reserve storage or dead storage. Both the 1984 NJIT study and the Wanaque Model indicate that the most severe drought of record for the previous 177 mgd safe yield estimate is the 1960's drought.

7. Results from the NJDWSC Wanaque Model, as submitted for the subject request, indicate that the safe yield of the existing Wanaque Water System is 208 mgd and the 1960's drought is the most severe drought of record for the system. This would be an increase of 31 mgd beyond the previous safe yield estimate of 177 mgd. (173 mgd is the safe yield historically accepted; however, 177 mgd is the safe yield identified in the 1984 NJIT Study). The Wanaque Model derives the requested 31 mgd increase in safe yield primarily from an increase of approximately 23 mgd in treated wastewater discharges coupled with three additional months of pumping per year at the TBPS when diversions are possible due to water quality (DO) improvements. In addition to these significant changes, the Wanaque Model applies a 6 mgd reduction of base flow during the 1960's drought due to groundwater withdrawals from well development in the Ramapo Valley Well Field in New York State.

8. As indicated above, results from the NJDWSC Wanaque Model as submitted, at 208 mgd of average annual demand, indicate that the 1960's drought would be the most severe drought of record for the Wanaque Water System and, therefore, that system storage would be drawn down to the minimum level during this drought. During the 1960's drought, the Wanaque Model indicates that the 36.6 bg of total combined water storage would decrease to a minimum level of about 3.8 bg. This remaining storage, excluding the dead storage of 0.282 bg, is designed to provide a margin of safety to the safe yield calculation and has the added effect of confining the critical duration of the 1960's drought to a one-year period. The inclusion of about 3.5 bg of reserve capacity as a safety factor, about 10 % (100*3.5/[36.6 - 0.282]) of the total usable NJDWSC storage, is a major revision since the safe yield estimates done in 1984 (by NJIT), when the reserve capacity was zero. There is no requirement for reserve storage in the Department of Environmental Protection's water allocation rules at this time.

9. The Wanaque Model utilized a flat average for representation of the significant wastewater treatment plant discharges. The Department of Environmental Protection has evaluated the sensitivity of safe yield to the variation of discharge rates, and found there is no significant difference between using an average rate of wastewater discharge and applying a seasonally fluctuating rate. This is probably due to the relatively minor proportion of the difference between these two discharge scenarios relative to the overall flows that are available from pumped diversions in a high-flow skimming type operation.

10. The Department of Environmental Protection has concluded that while increases in groundwater withdrawals in the Passaic River basin over the period of record will reduce stream flows in the basin during prolonged drought periods, they are not considered to have a significant impact on the Wanaque Water System safe yield because: 1) the watershed areas that provide natural runoff and groundwater base flow to the Wanaque/Monksville Reservoirs appear to be relatively unaffected by well development, and 2) the areas of well development in the Passaic, Pompton and Ramapo Rivers down stream of the reservoirs and upstream of the RRPS and TBPS appear to have a significant impact on low flows only, a range of flow less than the mandated passing flows in the NJDWSC water allocation permits. The Department of Environmental Protection also evaluated a range of estimates for the possible reduction of stream base flows due to depletive or consumptive well development in the Ramapo River watershed. Even if the Ramapo River low flows are lower, the nature of the withdrawals at the Ramapo and Two Bridges pump stations are such that no significant withdrawal is taking place during prolonged low flow events and the system total safe yield is not significantly impacted by a decrease of the historic low flows since the safe yield operating plan has

never relied upon stream flows in the flow range below about 15% of the average daily flow of the natural, unregulated, drainage area.

With respect to overall flows, examination of the USGS stream flow trends report (USGS, 2001), and other Department of Environmental Protection data indicates that the effects of groundwater withdrawals may be offset by other hydrologic modifications in northeastern New Jersey. Therefore, from a hydrologic perspective, the safe yield modeling assumption that the NJDWSC applied, that the Ramapo River flow is reduced by 6 mgd, appears to be a conservative assumption. The USGS trend analysis appears to establish a reliable record and data base since it entails such a long term of record, sometimes over a hundred years, in an area that has been substantially developed.

11. There are a number of possible reasons why development of water supply wells has not noticeably impacted overall regional stream flows. Given that the pattern of land development in the Passaic Basin and any of the other conditions that may contribute to the maintenance of regional stream flows is not likely to suddenly change, and the USGS stream flow data does not show a predominant decline in overall regional stream flows, it is unnecessary to superimpose a significant reduction in base flow in the daily reconstructed surface water flow record due to groundwater use at this time.

However, some caution must be taken on the use of trend analyses because factors such as precipitation rates may also be trending up thus masking the hydrologic effects of various land use, diversion or discharge changes. Due to the hydrologic complexity of the basin, there remains a level of uncertainty as to the full impact of potential future consumptive/depletive withdrawals and other hydrological conditions on stream flow and quality and their potential impact on the safe yield. Therefore the Department of Environmental Protection should continue to restrict new or additional consumptive/depletive diversions in the basin above the reservoirs and/or the diversion locations. In addition, the Department will continue to monitor the fate of wastewater in the basin to ensure that if discharge points are relocated, such relocation does not impact the proposed safe yield. The Department intends to initiate an in-depth study in the northeast region of the state to better identify and quantify the impacts various hydrological modifications in the basin have on safe yield and water supply. If the study in the northeast identifies and quantifies hydrologic issues that are inconsistent with the assumptions made in this safe yield analysis, or in the event that significant development occurs in the watershed in the future that is accompanied by a substantial reduction in stream flows, the Department reserves the right to re-evaluate the safe yield based on this more contemporary understanding of the basin if it determines such action is in the public interest.

12. As previously indicated, the Wanaque Model assumes that treated wastewater discharge volumes based on 1993 through 1996 USGS data are augmenting stream flows during prior years of the Wanaque Water System's period of record. This assumption increases the system's simulated sustainable supply for droughts that occurred during these prior years, including the 1960's drought. Available documentation of the methodologies for the daily natural surface water flow data that were used to create the reconstructed flow record and time series inputs for the NJDWSC Wanaque Model indicate that only observed purveyor surface water drafts, other purveyor diversions, purveyor diversion return flows (discharges from pump-storage operations), reservoir storage changes, and storage changes in Greenwood Lake were considered in the stream flow naturalization. A representative of the NJDWSC has verbally indicated that the effects of wastewater discharge volumes were removed from the daily natural surface water flow data before it was used in the Wanaque Model, as would be appropriate. Traditionally, these are the only types of hydrologic modifications that are considered when estimating safe yield. However, there are many other types

of hydrologic modifications that can occur over time (not just the increases in groundwater withdrawals discussed above) but that are not considered in the Wanaque Model. Many of these types of hydrologic modifications are associated with land use changes, which are relatively extensive within portions of the areas upstream of the RRPS and TBPS. The effects of these other types of hydrologic modifications on the safe yield of the Wanaque Water System are not well understood. This hydrologic complexity results in a level of uncertainty in the safe yield estimate. In order to help offset this uncertainty, the Department of Environmental Protection believes that there should be a conservative balance between the magnitudes of the volumes of the individual treated wastewater discharges (that increase the simulated sustainable supply of droughts before 1993) and the individual diversions of other upstream purveyors (that decrease the simulated sustainable supply of droughts before 1993) that are considered in the Wanaque Model and its reconstructed flow record. In general, this means that: wastewater discharges that are smaller than the smallest diversion should not be included in the model or its daily reconstructed surface water flow data; and that all existing surface water discharges and surface water diversions that are larger than this value should be included. This also means that projected future increases of treated wastewater discharge volumes should not be considered whereas diversions of the other upstream purveyors should be simulated at the maximum limit(s) allowed in accordance with their Department approved safe yield estimates, effective water allocation permits and physical capacities. The Wanaque Model includes treated wastewater discharges with annual average volumes as small as 0.44 mgd. This is likely smaller than the smallest diversion, although the NJDWSC has not provided detailed data regarding the diversions of other upstream purveyors included in the model's reconstructed flow data. This would be a significant issue, except that the Department of Environmental Protection believes that it is adequately offset by other mitigating factors in this case. These mitigating factors are that: the treated wastewater discharge volumes included in the Wanaque Model are based on 1993 through 1996 data rather than more current data, which would likely reflect increased wastewater volumes, and about 3.5 bg of reserve capacity has been included in the Wanaque Model as a safety factor.

13. It was not possible for the Department of Environmental Protection to validate the NJDWSC Wanaque Model by comparison with the actual storage remaining in the Wanaque Water System reservoirs during recent drought events by using the current demand, about 130 mgd. This might be a good means of validation if NJDWSC operated to maximize pumping and storage. However, the NJDWSC does not generally maximize pumping and storage; it maintains a margin of safety and balances the pumping against the demand in a manner that manages costs. Since the Wanaque Water System's current average demand is substantially less than the previously approved safe yield, NJDWSC's operations are largely a matter of practical experience. NJDWSC has maintained that its operations, to date, have provided a safe water supply at reasonable cost.

14. The Department of Environmental Protection has created a draft computer simulation model of the Wanaque Water System using RiverWare™ hydrologic modeling software. RiverWare software is supported and maintained by the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) at the University of Colorado. The draft RiverWare model of the Wanaque Water System, developed by the Department, is based on NJDWSC's Wanaque Model of the system. The draft RiverWare model uses applicable data from the NJDWSC Wanaque Model, including daily reconstructed surface water flow data from October 1, 1919 through December 31, 2003 that were used to create time series inputs for the control points in the Wanaque Model. The following treated wastewater discharge quantities from the Wanaque Model were used at a constant daily rate:

* WASTE WATER TREATMENT PLANTS EFFLUENCE (USGS 1993-1996):
WANAQUE RIVER ABOVE WANAQUE RESERVOIR 0.00 mgd
RAMAPO RIVER ABOVE POMPTON LAKES 6.33 mgd
RAMAPO RIVER BETWEEN POMPTON LAKES AND POMPTON PLAINS 0.84 mgd
POMPTON RIVER BETWEEN POMPTON PLAINS AND T.B. 5.88 mgd
PASSAIC RIVER ABOVE T.B. 47.38 mgd
PASSAIC RIVER BETWEEN T.B. AND L.F. 7.04 mgd
TOTAL ABOVE L.F. 67.47 mgd

Other data gathered by the Department of Environmental Protection were also used in the draft RiverWare model. Unlike the Wanaque Model, RiverWare software generally uses hydraulic relationships to model reservoir spills and releases. As a result, data regarding reservoir pool elevation and volume relationships, pool elevation and spill relationships and pool elevation and discharge (release) relationships have been included in the model.

15. A report entitled "DOCUMENTATION OF PASSAIC RIVER BASIN DAILY NATURAL FLOW DATA DEVELOPMENT", prepared by Clinton Bogart Associates and dated May, 1982 has shown that the timing of daily high and low flows at the USGS Passaic River at Little Falls, New Jersey Gage (No. 01389500) does not correlate well with upstream gages. This may be due, in part, to decreases in flow velocity caused by a substantial area of relatively low relief that is mostly upstream of the confluence of the Pompton and Passaic rivers at Two Bridges. This area is a remnant of ancient Lake Passaic that once covered much of the region. The lack of correlation causes problems (such as negative local inflows calculated from daily reconstructed surface water flow data) in daily time-step water accounting models. To help overcome these issues, remnant Lake Passaic has been modeled hydraulically as a reservoir using the RiverWare software. The pool elevation and unregulated spill table for remnant Lake Passaic in the draft RiverWare model has been roughly calibrated to delay high flows so that the timing of daily high and low flows at the USGS Little Falls gage correlates better with upstream gages. The delay in high flows in the draft RiverWare model provides limited additional time for diversions at the TBPS in comparison with NJDWSC's Wanaque Model.

16. Using the draft RiverWare model with the NJDWSC Wanaque Model's daily reconstructed surface water flow data from October 1, 1919 through December 31, 2003, the Department of Environmental Protection was able to replicate the 208 mgd safe yield from NJDWSC's Wanaque Model with about 3.9 bg and 0.2 bg of storage remaining in the Wanaque and Monksville reservoirs, respectively.

17. The Department of Environmental Protection has also attempted to calibrate the draft RiverWare model to observed combined storage in the Wanaque and Monksville reservoirs and to observed daily surface water flow data at USGS gages Nos. 01389500 (Passaic River at Little Falls, New Jersey), 01388500 (Pompton River at Pompton Plains, New Jersey) and 01381900 (Passaic River at Pine Brook, New Jersey). The calibration process included a series of model runs from January 1, 2000 through December 31, 2003 and focused on the 2001-2002 drought. Initial additional input data used to calibrate the model runs included the following:

- Observed daily flows at USGS gage No. 01383500 (Wanaque River at Awosting, New Jersey), including actual releases from Greenwood Lake;

- Observed daily flows at USGS gage No. 01387000 (Wanaque River at Wanaque, New Jersey), including actual releases from the Wanaque Reservoir;

- Reported NJDWSC monthly demands from Department of Environmental Protection records, interpolated to a daily time step. The reported demand for each month was assigned to the temporal mid-point of the month and linear interpolation was used to determine the demand for each daily time step;

- Daily diversions at the Ramapo and Two Bridges pumping stations by NJDWSC and UWNJ, from Department of Environmental Protection data; Passing flows at Pompton Lakes and Two Bridges in the model were set to zero, so as not to restrict the diversions. Although passing flows are maintained in simulations that estimate safe yield, actual diversions should be enabled when simulating actual conditions to calibrate the model to observed storage and flow data. It should be noted that, even without the passing flows, not all reported diversions could be made in the model;

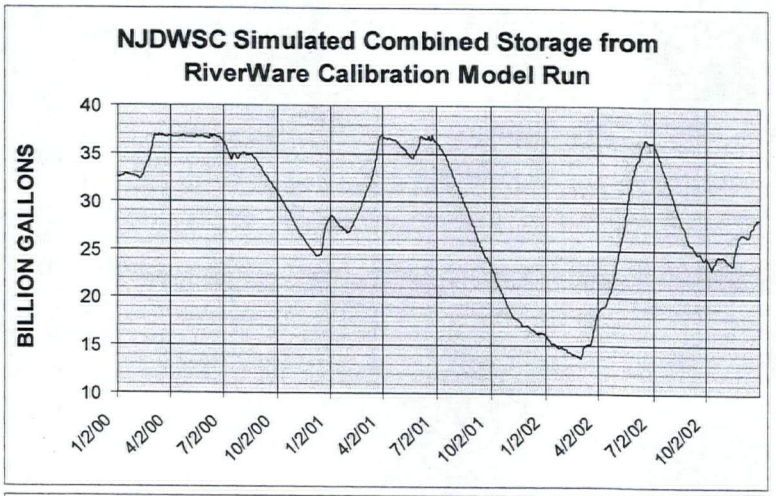
- Monthly diversions at the Jackson Avenue pumping station by the PVWC as reported in the USGS "Water Resources Data New Jersey Water Year 2002, Volume 1. Surface-Water Data, Water-Data Report NJ-02-1". These include diversions of 1.15, 27.8 and 1.03 cfs during the months of March, April and May, 2002, respectively. In the draft RiverWare model these diversions were input as 5.0 mgd on March 29, 9.0 mgd on March 30 and 31, 18.0 mgd on April 1 through May 1, and 3.0 mgd on May 2. No passing flow in the Pompton River at Jackson Avenue was used in the model, so as not to restrict the diversions. As above, although passing flows are maintained in simulations that estimate safe yield, actual diversions should be enabled when simulating actual conditions to calibrate the model to observed storage and flow data. All of the simulated Jackson Avenue Pumping Station diversions were available in the model;

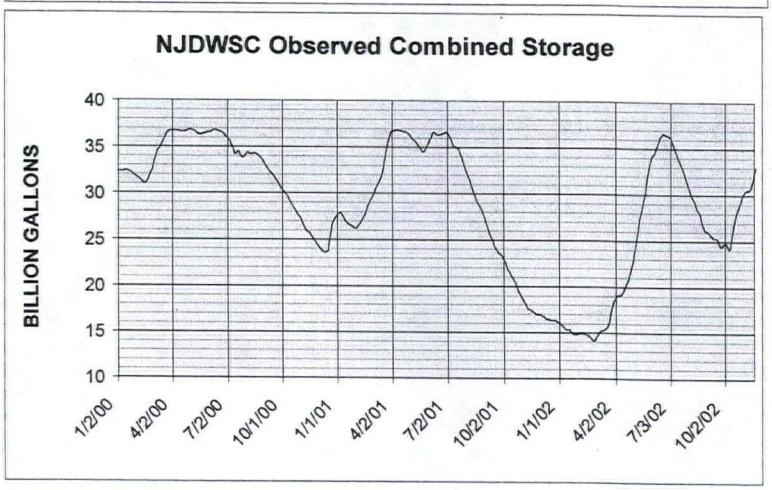
- Daily PVWC demands, as obtained from PVWC data. The draft RiverWare model assumes that the first 50 mgd of PVWC daily demand is diverted at the Two Bridges intake, to the extent available, and the remainder, to the extent available, is diverted at the Little Falls intake;

- An initial observed pool elevation of 297.09 feet above mean sea level on January 1, 2000 for the Wanaque Reservoir from http://waterdata.usgs.gov/nwis; and

- An initial observed pool elevation of 619.03 feet above mean sea level (Datum of 608.86 plus gage height of 10.17) on January 1, 2000 for Greenwood Lake from http://waterdata.usgs.gov/nwis.

18. In the output from the calibration runs of the draft RiverWare model, the simulated combined storage in the Wanaque and Monksville reservoirs compared favorably with Department of Environmental Protection records of observed storage as shown below.





19. In the output from the initial calibration runs, the Department of Environmental Protection found that simulated surface water flows of the draft RiverWare model at USGS gages Nos. 01389500 (Passaic River at Little Falls, New Jersey), 01388500 (Pompton River at Pompton Plains, New Jersey) and 01381900 (Passaic River at Pine Brook, New Jersey) were significantly higher than observed flows during the critical duration of the 2001-2002 drought. The differences are great enough so as to significantly overestimate the sustainable supply of the Wanaque Water System during the 2001-2002 drought. Reducing the simulated flows to more closely match the observed gage flows results in a sustainable supply for the Wanaque Water System that is significantly less than 208 mgd. The Department of Environmental Protection has identified several possible reasons that may contribute to this lack of correlation as follows:

- Diversions from the City of Newark Pequannock River Reservoir System, representing the safe yield of that system, may not have been accurately accounted for in the NJDWSC daily reconstructed surface water flow data used to create time series inputs for the NJDWSC Wanaque Model and the draft RiverWare model;

- Treated wastewater discharge volumes were apparently not subtracted from the NJDWSC daily reconstructed surface water flow data for the Ramapo River (above Pompton Lakes) that were used to create time series inputs for the NJDWSC Wanaque Model (Wanaque model control point No. 24) and the draft RiverWare model. As a result, the 6.33 mgd of wastewater

being added by the models to simulated surface water flows at this location is being double-counted. It is uncertain whether this issue applies to other control points in the models; and

- Local inflows to the Passaic River between Two Brides (Wanaque Model control points 50 and 60) and Little Falls (Wanaque Model control point 29)calculated from the NJDWSC daily reconstructed surface water flow data for the NJDWSC Wanaque Model and the draft RiverWare model were overestimated.

In addition to these issues, other undetermined factors are also required in order to explain the lack of correlation.

20. The correlation in the calibration runs of the draft RiverWare model between simulated and observed flows at USGS gages Nos. 01389500, 01388500, and 01381900 during the critical duration of the 2001-2002 drought can be significantly improved by:

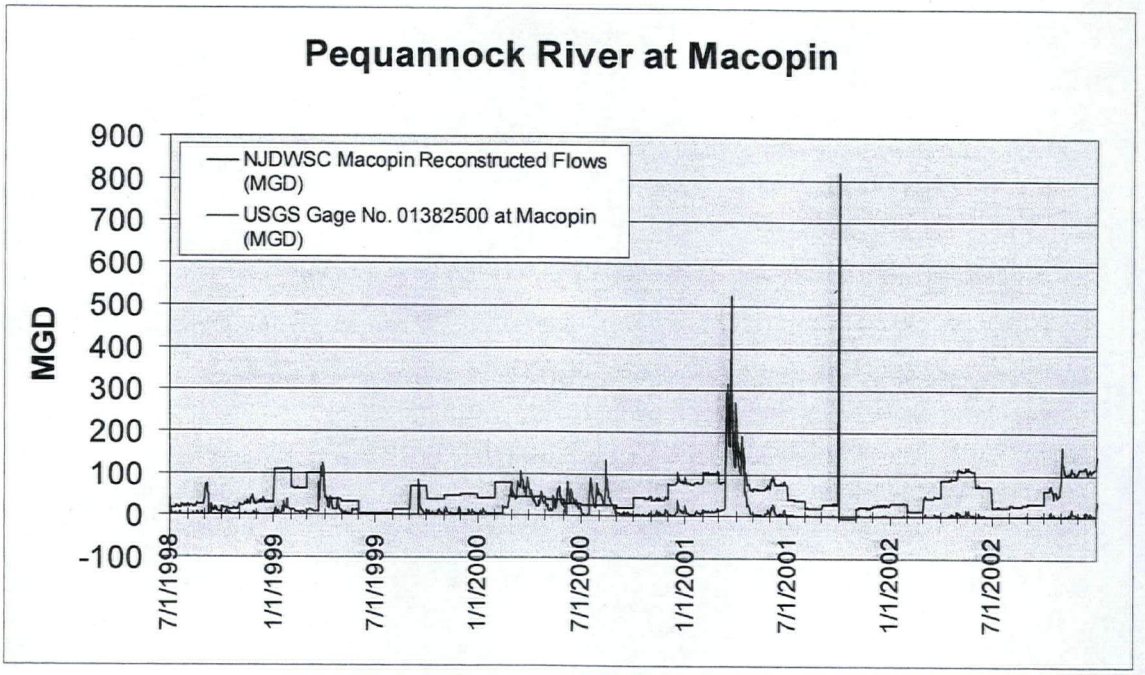
- Substituting daily flows observed at USGS gage No. 01382500 (Pequannock River at Macopin Intake Dam, New Jersey), just downstream of the City of Newark Pequannock River Reservoir System, for the daily reconstructed surface water flow data that were used to create time series inputs for the model at that location;

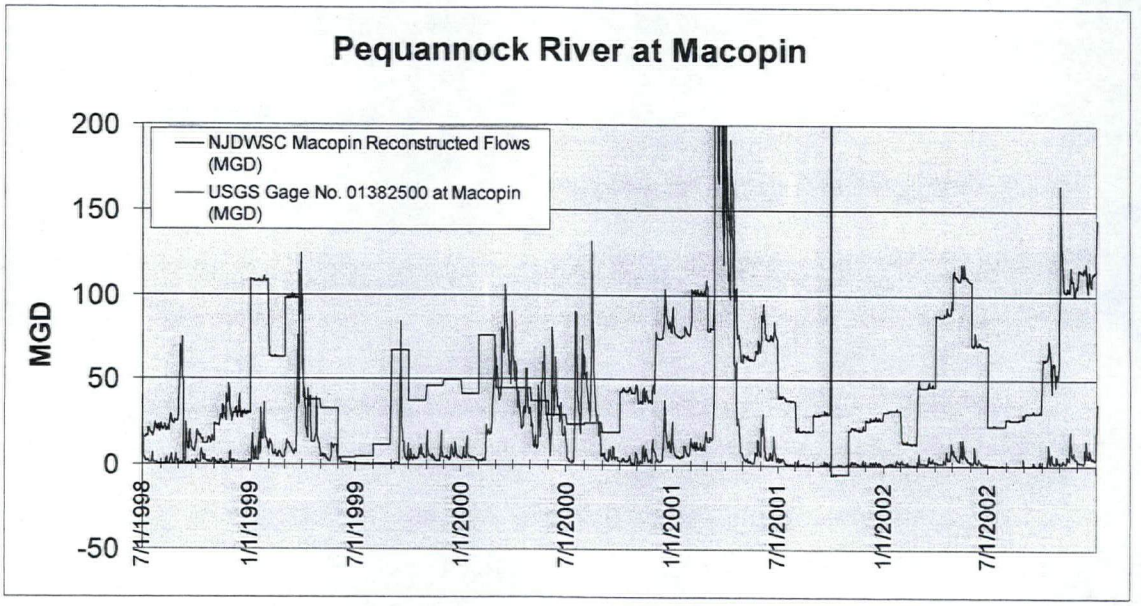
- Removing all treated wastewater discharge quantities from the draft RiverWare model; and

- Removing simulated local inflows to the Passaic River between Two Bridges and Little Falls (Wanaque Model control point 29) that were calculated from the reconstructed flow data for those locations.

21. Examination of the NJDWSC daily reconstructed surface water flow data for the Wanaque Model indicates that the issues with the data during the 2001-2002 drought are not limited to that time period and may extend back to October 1, 1979, as further explained below:

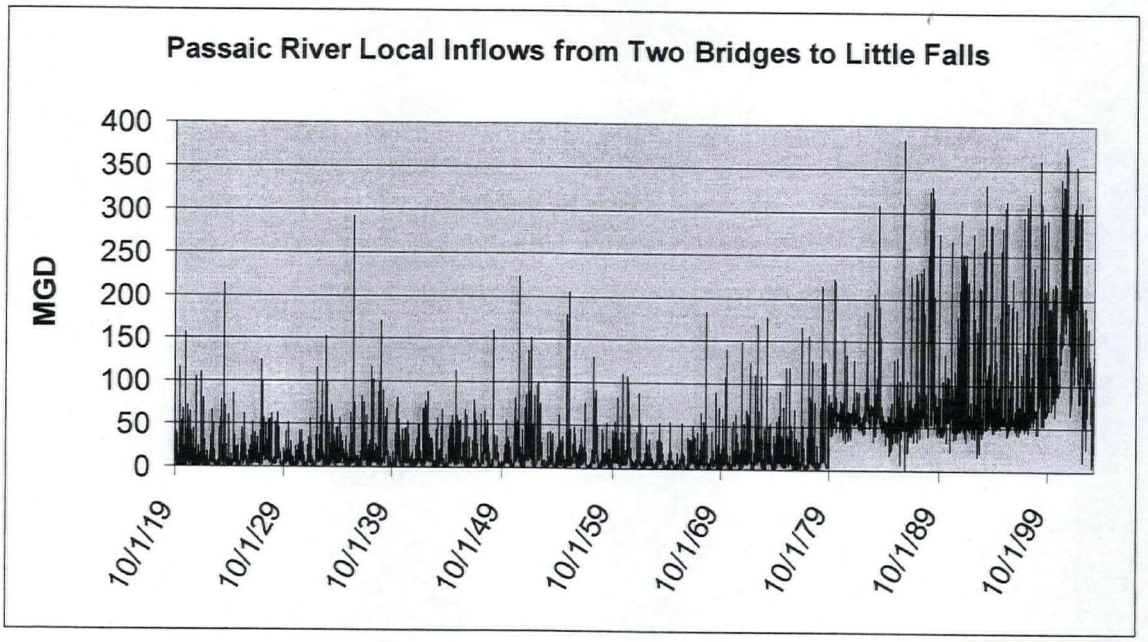
- Two graphs comparing the NJDWSC's daily reconstructed surface water flow data for the Pequannock River at the Macopin Intake Dam with daily flows observed at the USGS gage No. 01382500 at that location from July 1, 1998 to December 31, 2002 are provided below. It can be seen that the NJDWSC reconstructed flows are significantly higher than USGS gage flows for much of the time, not just during the 2001-2002 drought. For example, during August 1998 through January 1999, in the midst of the 1998-1999 drought, the total reconstructed flow is approximately 6.38 bg (34.7 mgd) higher on average than the total USGS gage flow. This is during a time period when, based on USGS data, average demand on the City of Newark Pequannock River Reservoir System was about 47.6 mgd, which is less than the approved safe yield estimate for that system, and the system's downstream reservoir was not spilling. The total reconstructed flow should be based on diverting the approved safe yield of the Pequannock River Reservoir System and should not be greater than the total USGS gage flow during this time period.





- For every day during calendar year 2000, NJDWSC's daily reconstructed surface water flows for the Ramapo River at Pompton Lake are equal to the daily flows observed at the USGS Gage No. 01388000 at that location. There were no actual diversions reported at the RRPS at that location during calendar year 2000. Treated wastewater discharge flows should be subtracted from the USGS gage flows in order to calculate reconstructed flows because the NJDWSC Wanaque Model adds 6.33 mgd of treated wastewater flow back to the reconstructed flows at this location. This wastewater discharge quantity is from a 2001 USGS report and is based on 1993 through 1996 data, so calendar year 2000 USGS gage flows should include at least this amount of wastewater flow. The fact that treated wastewater discharge flows are not subtracted indicates that wastewater flows are being double-counted in the NJDWSC Wanaque Model during calendar year 2000.

- One of the issues with the NJDWSC daily reconstructed surface water flow data is with local inflows to the Passaic River between Two Bridges and Little Falls that were used as time series inputs for the NJDWSC Wanaque Model and the draft RiverWare model. These local inflows were calculated on a daily basis by subtracting the sum of daily reconstructed surface water flows at Two Bridges (Wanaque Model Control Points 50 and 60) from the daily reconstructed surface water flows at Little Falls (Wanaque Model Control Point 29). These local inflows were significantly overestimated during the 2001-2002 drought. Below is a graph of these local inflows into the Passaic River between two Bridges and Little Falls from October 1, 1919 through December 31, 2003, as calculated by the Department of Environmental Protection.



It can be seen that there is a significant increase in calculated local inflows beginning on October 1, 1979 and extending through the 2001-2002 drought. This is an indication that the issues with the NJDWSC daily reconstructed surface water flow data may extend from the 2001-2002 drought back to October 1, 1979. The reason for the increase in calculated local inflows has not been explained.

22. The reasons for the issues with the daily reconstructed surface water flow data for the Wanaque Model described in items 19, 20 and 21 of the Staff Analysis and Conclusions section could be further understood, and the issues might be able to be resolved, through examination of the basis of the reconstructed flow data. However, the NJDWSC has not provided the majority of the basis of the reconstructed flow data to the Department of Environmental Protection. The reconstructed flow data were created using daily natural surface water flow data. To the Department's knowledge, the daily natural surface water flow data were initially developed by Clinton Bogart Associates through September 30, 1979 and were later extended on at least 2 separate occasions by Lawler, Matusky and Skelly Engineers (LMS). As previously indicated the Department has a report entitled "DOCUMENTATION OF PASSAIC RIVER BASIN DAILY NATURAL FLOW DATA DEVELOPMENT", prepared by Clinton Bogart Associates and dated May, 1982. This 1982 report contains partial documentation of the methodologies used to develop the daily natural surface water flow data through September 30, 1979, but does not contain the associated raw data, daily calculations or the actual natural flow data. The 1982 report indicates that the natural flow data were

developed at various control points using observed surface water flow data from USGS gage station locations. According to the 1982 report, in some cases, the observed surface water flow data were used as the natural flow data for the time periods and locations of the observations. Natural flow data at some other control points and during some other times were developed from observed surface water flow data by: adding observed upstream purveyor surface water drafts, adding other observed purveyor diversions and water storage changes; and subtracting observed upstream purveyor diversion return flows (discharges from pump-storage operations). Other natural flow data were developed using surface water flow synthesis methods, some of which involved the use of drainage area ratios and linear regression analyses. In general, the 1982 report refers to all of this natural flow data as reconstructed natural flows including observed values, values calculated using addition and/or subtraction as described above, and values estimated using surface water flow synthesis methods. When referring to the process of reconstructing surface water flow data, this staff report uses a similar meaning in order to maintain consistency. However, when this staff report refers to the daily reconstructed surface water flow data that were used to create time series inputs for the NJDWSC Wanaque Model, it should be understood that this is not referring to the natural flow data but rather a separate data set that was developed using the natural flow data.

23. In a letter dated July 1, 2008, the Department of Environmental Protection informed NJDWSC of the issues with the daily reconstructed surface water flow data for the Wanaque Model(stream flow reconstruction issues). An attachment to the letter indicated that, based on a preliminary analysis, some of the issues identified during the 2001-2002 drought may extend back in time to October 1, 1979. In order to address these issues, NJDWSC was advised to submit the raw data, daily calculations and natural flows that were used to create the reconstructed flow record and time series inputs for all of the control points in the NJDWSC Wanaque Model to the Department for review. This includes the time period from October 1, 1919 through December 31, 2003. NJDWSC was advised to include an explanation and justification for the methodologies used to create the natural flows and reconstructed flow record since October 1, 1979 in the submittal.

24. NJDWSC representatives have indicated that they only have the reconstructed flow record for the NJDWSC Wanaque Model and do not have the associated raw data, daily calculations, natural flows, or the methodologies used since October 1, 1979. NJDWSC representatives also indicated that obtaining the requested data from the applicable engineering firm would require hundreds of thousands of dollars in expenditures and at least one year of time.

25. In response to the Department of Environmental Protection's July 1, 2008 letter, NJDWSC submitted a separate Microsoft Excel spreadsheet model that is focused on estimating the sustainable supply of the Wanaque Water System during the 2001-2002 drought. The NJDWSC Excel spreadsheet model, as initially submitted, indicated that, at 208 mgd of average annual demand, a minimum of about 1.5 bg of water would remain in storage. The minimum storage of 1.5 bg from the NJDWSC Excel model during the 2001-2002 drought is less than the minimum of 3.8 bg from the NJDWSC Wanaque Model during the 1960's drought. As initially submitted, the Wanaque Model indicates that the safe yield is 208 mgd and the NJDWSC Excel spreadsheet model indicates that the sustainable supply is 208 mgd, but the difference in minimum storage indicates that the 1960's drought may not be the most severe drought of record for the Wanaque Water System. The NJDWSC Wanaque Model indicates that the minimum level of water storage during the 2001-2002 drought would be about 10.0 bg at 208 mgd of average annual demand.

26. The Department of Environmental Protection reviewed the NJDWSC Excel spreadsheet model and examined the model structure, assumptions, calculations and input data. This model performs calculations on a daily time step. The NJDWSC Excel spreadsheet model reconstructs stream flows in the Ramapo River at Pompton Lakes dam by adding observed NJDWSC and UWNJ diversions at the RRPS to observed stream flows at USGS gage No. 01388000 at that location. The NJDWSC Excel spreadsheet model reconstructs stream flows in the Passaic River at Little Falls by adding observed NJDWSC, UWNJ and PVWC diversions at the RRPS, TBPS and Little Falls intake to observed stream flows at USGS gage No. 01389500 in the Passaic River at Little Falls. The NJDWSC Excel spreadsheet model reconstructs stream flows at the confluence of the Passaic and Pompton rivers by subtracting 7.05 mgd of treated wastewater discharge (Wayne Township Mountainview wastewater treatment plant) from the reconstructed stream flows in the Passaic River at Little Falls and then dividing the result by a drainage area ratio. The NJDWSC Excel spreadsheet model reconstructs gravity inflows into the Monksville and Wanaque reservoirs by calculating the change in observed storage volume from the previous day, subtracting observed diversions from the RRPS and TBPS to the Wanaque Reservoir, adding observed withdrawals from the Wanaque Reservoir, and then adding observed releases from the Wanaque Reservoir as measured at USGS gage No. 01387000 located just below the reservoir.

27. Although the augmenting effect of increased treated wastewater discharges is a significant factor in the Wanaque Model, assuming the 1960's drought is the most severe drought of record, NJDWSC did not need to consider this factor in the Excel spreadsheet model of the Wanaque Water System, which focuses on the 2001-2002 drought. As previously indicated, treated wastewater discharge volumes have been increasing over time and the Wanaque Model uses average treated wastewater volumes discharged during the period 1993 to 1996. Increased wastewater volumes up to the time of the 2001-2002 drought are already incorporated into the stream flow and reservoir level gage data that were used to develop reconstructed stream flows for the NJDWSC Excel spreadsheet model. Also, as previously indicated for the Wanaque Model, the Department of Environmental Protection does not believe that any projected future increases of treated wastewater discharge volumes should be considered in the NJDWSC Excel spreadsheet model. Any such projected future increases should be excluded as a conservative assumption to offset uncertainties associated with other potential future hydrologic modifications that may occur within the watersheds of the Wanaque Water System.

28. The Department of Environmental Protection identified a number of issues with the NJDWSC Excel spreadsheet model and began to verbally communicate these issues to NJDWSC representatives.

29. After being advised of the stream flow reconstruction issues regarding the NJDWSC Wanaque Model (addressing the period October 1919 through December 2003) and a number of the issues regarding the NJDWSC Excel spreadsheet model (focusing on the 2001-2002 drought), NJDWSC representatives informed the Department of Environmental Protection that they believe that the safe yield of the Wanaque Water System should be based on the 1960's drought. This is because the NJDWSC representatives believe that the 1960's drought is the most severe drought of record for the Passaic River Basin, regardless of which drought produces the least water supply yield for the Wanaque Water System. It was later clarified that the NJDWSC representatives believe that the drought of record is a hydrologic event and should not be defined based on regulatory restrictions on surface water supply reservoir systems. The Department of Environmental Protection believes that, within a surface water supply reservoir system's period of record, the most severe drought of record for the system is the drought that produces the least water supply yield for that system, without interruption on a daily basis, and that this yield is the safe yield of the system. The Department of

Environmental Protection believes that applicable regulatory restrictions as well as limitations of the purveyor's own operating plans and physical limitations of the system should be used in a consistent way to both determine the most severe drought of record and to estimate safe yield.

30. On Wednesday August 6, 2008, during a conference call, a representative of NJDWSC informed representatives of the Department of Environmental Protection that NJDWSC believes the Department has all of the information necessary to reach a decision regarding the request to approve 208 mgd as the Wanaque Water System safe yield and that NJDWSC did not intend to provide any further information prior to that decision.

31. With a letter dated February 13, 2009, the Department of Environmental Protection provided the NJDWSC with its February 11, 2009 draft staff report and technical evaluation regarding the Wanaque Water System safe yield. The letter indicated that the Department was unable to verify that the NJDWSC safe yield could be increased at that time and that the key concern remained the stream flow reconstruction issues identified in the Department's July 1, 2008 letter to the NJDWSC. The February 11, 2009 draft staff report indicated that examination of the reconstructed stream flow data indicates that the issues during the 2001-2002 drought may extend back to October 1, 1979. The February 13, 2009 letter provided the NJDWSC with an additional opportunity to address the Department's concerns.

32. At an April 14, 2009 meeting among representatives of the NJDWSC, the Department of Environmental Protection and UWNJ, the NJDWSC provided the Department with an updated version of their Microsoft Excel spreadsheet model that is focused on estimating the sustainable supply of the Wanaque Water System during the 2001-2002 drought. The model was updated to address some of the concerns raised in the Department's February 11, 2009 draft staff report and was peer reviewed by Najarian Associates. At the April 14, 2009 meeting, a NJDWSC representative explained two simulations using the updated Microsoft Excel spreadsheet model. One of the simulations assumed that the City of Newark's Pequannock River Reservoir System released enough water to maintain a flow of 7.95 mgd (12.3 cfs) at USGS gage No. 01382500 (Pequannock River at Macopin Intake Dam, New Jersey). This simulation resulted in a sustainable supply of 196.1 mgd for the Wanaque Water System during the 2001-2002 drought. The other simulation assumed that there was no release from the Pequannock River Reservoir System and resulted in a sustainable supply of 191.1 mgd for the Wanaque Water System during the 2001-2002 drought. These simulations were based on a total dead storage for the Wanaque Water System of 0.22 bg and no reserve storage. It was later clarified that the total dead storage of the Wanaque Water System is 0.282 bg, as previously indicated.

33. The Department of Environmental Protection reviewed the updated NJDWSC Excel spreadsheet model and confirmed that it addressed many of the issues about that model that had been raised in the Department's February 11, 2009 draft staff report. The updated spreadsheet model, which is focused on the 2001-2002 drought, did not address the Department's concern that the issues with NJDWSC's daily reconstructed surface water flow data may extend back to October 1, 1979 and did not provide any additional basis for the Wanaque Model's reconstructed flow data. With regard to the City of Newark's Pequannock River diversion, N.J.S.A. 58:2-1 and N.J.A.C. 7:19-4.6(e) established a passing flow requirement of 12.3 cfs (7.95 mgd) at the Macopin gaging station. This passing flow requirement is not a flow that must be maintained at all times, rather it is a value that is used to determine the City of Newark's excess diversion fee. At the time of the April 14, 2009 meeting, the City of Newark's water allocation permit No. 5123 did not require that a passing flow be maintained

at any location. When the Department used a permitted passing flow of 0 mgd for the Pequannock River Reservoir System and a total dead storage for the Wanaque Water System of 0.282 bg in the updated NJDWSC Excel spreadsheet model, the sustainable supply of the Wanaque Water System during the 2001-2002 drought was estimated to be about 191 mgd. On October 21, 2009, the Department modified water allocation permit No. 5123 to require the City of Newark to make bottom releases from Charlotteburg Reservoir so that the daily mean stream flow monitored at the proposed USGS gaging station to be installed immediately downstream of the Charlotteburg Reservoir Dam is greater than or equal to 4.4 cfs (2.84 mgd), as real time data reported daily on the USGS website for the station. This permitted passing flow is not required when the storage level in the Pequannock River Reservoir System is less than the mid-point between the long term average storage level and the drought watch level as established by the Department for seven consecutive days or more. When the Department used a permitted passing flow of 2.84 mgd for the Pequannock River Reservoir System (without consideration of elimination of the passing flow requirement under the specified storage conditions) and a total dead storage for the Wanaque Water System of 0.282 bg in the updated NJDWSC Excel spreadsheet model, the sustainable supply of the Wanaque Water System during the 2001-2002 drought was estimated to be about 192 mgd.

34. The Department of Environmental Protection has independent access to USGS monitoring data for surface water quality parameters near the NJDWSC diversions from the Passaic, Pompton, and Ramapo rivers and has verified that the DO parameter has improved since 1984. For NJDWSC safe yield modeling purposes(excluding the July-August period), water quality has improved to the extent that DO does not pose significant withdrawal restrictions during times when the quantities of stream flow are at levels high enough to pump and still meet passing flow requirements. However, as treated wastewater discharges become a larger component of the available water to be pumped, other water quality issues may arise. For example, nitrate is considered an acute contaminant under the safe drinking water standards. The Department continues to assess and evaluate the risks posed by increased nitrate levels on water supply. While nitrate concentrations have not yet adversely impacted the ability of downstream diverters to meet safe drinking water standards, nitrate concentrations in source water have reached levels of concern. Continued monitoring and additional actions by the Department may be necessary to manage contaminants in the source water so safe drinking water standards are not exceeded.

35. The requested new safe yield entails no changes in current allowable diversion amounts, diversion rates, operations, or conditions pursuant to NJDWSC's existing water allocation permits. No new water supply diversion locations were added or developed. For those months when diversions and pumping are allowed (excluding the July-August period), the DO concentrations at the TBPS and RRPS are typically within the limits of the water allocation permits under which NJDWSC is currently authorized to pump. The DO condition was incorporated into the 1980's water allocation permit for the Wanaque South Project because of the poor water quality that existed during low flow conditions at that time and to prevent exacerbating such conditions, should they exist, under any flow conditions. The DO condition was considered a "surrogate" for the amount of wastewater in the river at low flow. While DO has improved, the river flow still includes a large fraction of treated wastewater during low flow. However, due to the regulatory passing flow conditions at the RRPS and TBPS, water diverted to the reservoirs will be from a higher stream flow range that affords greater levels of dilution; water quality during the low flows at times when NJDWSC cannot pump and must meet passing flow requirements should be consistent with current conditions.

36. Water conservation activities should not significantly reduce treated wastewater flow contributing to the safe yield during future droughts even if water conservation significantly reduces the overall amount of diversion needed, per capita. The vast majority of future water conservation programs will mainly affect outdoor water use and industrial use, and will not likely reduce the amount of wastewater discharged. That is, as per capita water use declines, per capita discharge should remain relatively stable.

37. Demand reductions during drought and the relaxation of regulatory restrictions, including passing flow requirements, for the Wanaque Water System are reserved to provide a margin of safety and compensate for uncertainties in the safe yield estimate, including the possibility that a drought more severe than the most severe drought of record may occur. The Department of Environmental Protection believes that this is in accordance with the definition of safe yield in the Water Supply Management Act, P.L. 1981, C. 262 (N.J.S.A. 58:1A).

38. The following possibly significant uncertainties remain with regard to the safe yield estimate of the Wanaque Water System and are not adequately offset by safety factors and conservative assumptions:

    a. NJDWSC has not submitted to the Department of Environmental Protection for review, the raw data, daily calculations and daily natural surface water flow data for the time period from October 1, 1919 through December 31, 2003 that were used to create the reconstructed flow record and time series inputs for all of the control points in the NJDWSC Wanaque Model. No explanation or justification for the methodologies used to create the natural flow data and reconstructed flow record for the Wanaque Model since October 1, 1979 has been provided. When the Department used the portion of the reconstructed flow record including the 2001-2002 drought as an input to the draft RiverWare model, the simulated flows were significantly higher than observed daily surface water flow data at USGS gages Nos. 01389500 (Passaic River at Little Falls, New Jersey), 01388500 (Pompton River at Pompton Plains, New Jersey) and 01381900 (Passaic River at Pine Brook, New Jersey). Examination of the NJDWSC daily reconstructed surface water flow data for the Wanaque Model indicates that the issues with the data during the 2001-2002 drought are not limited to that time period and may extend back to October 1, 1979. As a result, the Department has reason to believe that the NJDWSC Wanaque Model may significantly overestimate the sustainable supply of the Wanaque Water System during the period from October 1, 1979 through December 31, 2003. This issue is directly related to a basic requirement of the safe yield estimate, that it be based on conditions analogous to a repeat of the most severe drought of record, in accordance with the definition of safe yield in the Water Supply Management Act, P.L. 1981, C. 262 (N.J.S.A. 58:1A). The Department believes that the most severe drought of record for the Wanaque Water System is determined by evaluating the daily reconstructed surface water flow data for the system's entire period of record and identifying the drought that produces the least water supply yield for that system, without interruption on a daily basis. Because the daily reconstructed surface water flow data can not be relied upon for a substantial recent portion of the period of record, this basic requirement can not be met. Because this is a statutory requirement, the uncertainty associated with this issue should not be permitted to be offset by other safety factors or conservative assumptions. Given the issues with the reconstructed flow record for the time period since October 1, 1979, the Department would also like to review similar data for the time period from October 1, 1919 through September 30, 1979 to verify the acceptability the reconstructed flow record for that time period.

b. The updated NJDWSC Excel spreadsheet model, which focuses on the 2001-2002 drought, does not account for the full utilization of the diversions from the Passaic River and Canoe Brook by New Jersey American Water (NJAW) under water allocation permit No. 5008. These diversions are upstream of the TBPS and can reduce flows available to the Wanaque Water System. The NJDWSC has indicated that it is speculative to suggest that these diversions will be fully utilized. The Department of Environmental Protection believes that as long as the applicable water allocation permit is in effect and the applicable physical facilities have the capability to divert the water, the full utilization of these diversions should be accounted for when estimating the safe yield of the Wanaque Water System. NJAW is entitled to consider the full utilization of its permitted diversions when estimating the safe yield of its water supply facilities and is permitted to actually divert the water. If NJAW does divert this water, it will be unavailable to the Wanaque Water System. It is equally speculative to suggest that NJAW will not fully utilize its permitted diversions under water allocation permit No. 5008. The uncertainty associated with this issue is not offset by reserve storage or any other safety factors or conservative assumptions in the updated Excel spreadsheet model. Although there is no specific requirement for reserve storage in the Department's water allocation rules at this time, uncertainties such as this should either be addressed directly or offset by safety factors and/or conservative assumptions in order to insure that the Wanaque Water System can provide a sufficiently reliable water supply that will protect the health, safety and welfare of the system's users.

39. Based on the information above, the NJDWSC has not provided and the Department of Environmental Protection does not have a reliable estimate of the current safe yield of the Wanaque Water System. The safe yield of 173 mgd for the Wanaque Water System that was approved by the Department more than 30 years ago remains in effect.

40. In order to protect the health, safety and welfare of both existing and future users of the Wanaque Water System during future severe drought conditions, the timing of when the system's demand may approach its safe yield should not be considered when determining the appropriate reliability of the safe yield estimate. A less reliable estimate of safe yield should not be accepted simply because the Wanaque Water System's demand may not approach its safe yield in the near future.

References

Clinton Bogert Associates, 1982, Documentation of Passaic River Basin Daily Natural Flow Development.

DeLuca, M. J., Hoppe, H. L., Heckathorn, H. A., Gray, B. J., Riskin, M. L., 2003, Water Resources Data-New Jersey, Water Year 2002, Volume 3, Water Quality Data: United States Geological Survey, Water-Data Report Nj-02-3. Washington, D.C. United States Government Printing Office.

Dresnack, Robert, Golub, Eugene, and Salek, Robert, 1984, Safe Yield Study of the Passaic River Basin: New Jersey Institute of Technology.

Dresnack, Robert, Golub, Eugene, and Salek, Robert, 1986, Management and Safe Yield Study of the Passaic River Basin in New Jersey: New Jersey Institute of Technology.

Hatch Mott MacDonald, 2010, North Jersey District Water Supply Commission Ramapo Pump Station Intake Modifications Feasibility Study and Conceptual Design Report.

Hickman, R. Edward, Barringer, Thomas H.,1999, Trends in Water Quality of New Jersey Streams, Water Years 1986-1995: United States Geological Survey, Water-Resources Investigations Report 98-4204. Washington, D.C. United States Government Printing Office.

Hickman, R. Edward, 1997, Water Quality on Days of Diversion and Days of no Diversion, Pompton and Passaic Rivers, New Jersey, 1987-95: United States Geological Survey, Open-File Report 97-573. Washington, D.C. United States Government Printing Office.

Huang, Po-Shu, Najarian, Tavit O., Gunawardana, Vajira K., 1988, Influence of Wanaque South Diversion on the Trophic Level of Wanaque Reservoir and its Water Quality Management Program, Najarian & Associates, Incorporated, Eatontown, New Jersey.

Najarian, Tavit O., Gunawardana, Vajira K., 1985, Influence of Wanaque South Project on the Temperature and Dissolved Oxygen Regimes of the Pompton and Passaic Rivers, Najarian & Associates, Incorporated.

New Jersey Department of Environmental Protection, 1996, Water for the 21st Century: Vital Resource, New Jersey Statewide Water Supply Plan, Office of Environmental Planning, Trenton, New Jersey.

Noll, Dean C., 1972, Monksville Project Preliminary Engineering Report, North Jersey District Water Supply Commission, Wanaque, New Jersey.

North Jersey District Water supply Commission, 2005, Wanaque Reservoir System Safe Yield Study, North Jersey District Water Supply Commission, Wanaque, New Jersey.

North Jersey District Water supply Commission, 2007, North Jersey District Water Supply Commission 2006 Operations Report, North Jersey District Water Supply Commission, Wanaque, New Jersey.

Sherrerd, M. R., 1911, State Water-Supply Commission Report on the Development of a Water-Supply from the Wanaque River, with Letters of Transmittal, State Water Supply Commission, Trenton, New Jersey.

Spitz, Frederick J., 2007, Simulation of Surface-Water Conditions in the Nontidal Passaic River Basin, New Jersey: United States Geological Survey, Scientific Investigations Report 2007-5052. Washington, D.C. United States Government Printing Office.

Storck, Donald A., Nawyn, J. P., 2001, Reconstruction of Streamflow Records in the Passaic and Hackensack River Basins, New Jersey and New York, Water Years 1993-96: United States Geological Survey, Water-Resources Investigations Report 01-4078. Washington, D.C. United States Government Printing Office.

Watson, Kara M., Reiser, Robert G., Nieswand, Steven P., Schopp, Robert D., 2001, Streamflow Characteristics and Trends in New Jersey, Water Years 1897-2003: United States Geological Survey, Scientific Investigations Report 2005-5150. Washington, D.C. United States Government Printing Office.

Summary and Recommendations

The Department of Environmental Protection has completed its review of this request pursuant to N.J.A.C. 7:19-1 et. seq.

In a letter dated July 1, 2008, the Department of Environmental Protection informed NJDWSC of issues with the daily reconstructed surface water flow data for the Wanaque Model(stream flow reconstruction issues). An attachment to the letter indicated that, based on a preliminary analysis, some of the issues identified during the 2001-2002 drought may extend back in time to October 1, 1979. In order to address these issues, NJDWSC was advised to submit the raw data, daily calculations and natural flows that were used to create the reconstructed flow record and time series inputs for all of the control points in the NJDWSC Wanaque Model to the Department for review. This includes the time period from October 1, 1919 through December 31, 2003. Given the issues with the reconstructed flow data for the time period since October 1, 1979, the Department also wanted to review the basis of the reconstructed flow data for the time period from October 1, 1919 through September 30, 1979. NJDWSC was advised to include an explanation and justification for the methodologies used to create the natural flows and reconstructed flow record for the time period since October 1, 1979 in the submittal.

NJDWSC representatives have indicated that they only have the reconstructed flow record for the NJDWSC Wanaque Model and do not have the associated raw data, daily calculations, natural flows, or the methodologies used for the time period since October 1, 1979. NJDWSC representatives also indicated that obtaining the requested data from the applicable engineering firm would require hundreds of thousands of dollars in expenditures and at least one year of time.

In response to the Department of Environmental Protection's July 1, 2008 letter, NJDWSC submitted a separate Microsoft Excel spreadsheet model that is focused on estimating the sustainable supply of the Wanaque Water System during the 2001-2002 drought, as described in items 25, 26 and 27 of the Staff Analysis and Conclusions section above. The spreadsheet model did not address the Department's concern that the issues with NJDWSC's daily reconstructed surface water flow data may extend back to October 1, 1979 and did not provide any additional basis for the Wanaque Model's reconstructed flow data.

The Department of Environmental Protection identified a number of issues with the NJDWSC Excel spreadsheet model and began to verbally communicate these issues to NJDWSC representatives. After beginning to communicate these issues, on August 6, 2008, a representative of NJDWSC informed representatives of the Department that NJDWSC believed the Department had all of the information necessary to reach a decision regarding the request to approve 208 mgd as the Wanaque Water System safe yield and that NJDWSC did not intend to provide any further information prior to that decision.

With a letter dated February 13, 2009, the Department of Environmental Protection provided the NJDWSC with its February 11, 2009 draft staff report and technical evaluation regarding the Wanaque Water System safe yield. The letter indicated that the Department was unable to verify that the NJDWSC safe yield could be increased at that time and that the key concern remained the stream flow reconstruction issues identified in the Department's July 1, 2008 letter to the NJDWSC. The February 11, 2009 draft staff report again indicated that examination of the reconstructed stream flow data indicates that the issues during the 2001-2002 drought may extend back to October 1, 1979. The February 13, 2009 letter provided the NJDWSC with an additional opportunity to address the Department's concerns.

At an April 14, 2009 meeting among representatives of the NJDWSC, the Department of Environmental Protection and UWNJ, the NJDWSC provided the Department with an updated version of their Microsoft Excel spreadsheet model that is focused on estimating the sustainable supply of the Wanaque Water System during the 2001-2002 drought. The model was updated to address some of the concerns raised in the Department's February 11, 2009 draft staff report and was peer reviewed by Najarian Associates. The Department of Environmental Protection reviewed the updated NJDWSC Excel spreadsheet model and confirmed that it addressed many of the issues about that model that had been raised in the Department's February 11, 2009 draft staff report. The updated spreadsheet model, which is focused on the 2001-2002 drought, did not address the Department's concern that the issues with NJDWSC's daily reconstructed surface water flow data may extend back to October 1, 1979 and did not provide any additional basis for the Wanaque Model's reconstructed flow data.

NJDWSC has not provided any basis for the daily reconstructed surface water flow data for the Wanaque Model for the time period from October 1, 1979 through December 31, 2003. The updated NJDWSC Excel spreadsheet model did help to reduce uncertainty for the drought years 2001 and 2002 but still did not resolve a possibly significant uncertainty as described in item 38b of the Staff Analysis and Conclusions section. NJDWSC has only provided a partial basis for the reconstructed flow data for the period from October 1, 1919 through September 30, 1979.

Because it is very important to have a reliable safe yield estimate for the Wanaque Water System, it is very important to possess and substantiate the complete basis of the daily reconstructed surface water flow data for the NJDWSC Wanaque Model. The reconstructed flow data are a primary part of the input data that drive the model. Without the complete basis for the Wanaque Model's reconstructed flow data, it does not appear that there is sufficient basis to be confident in the model's results. It is reasonable to expect that any purveyor requesting the Department to approve a safe yield estimate for a surface water reservoir system should provide a complete basis for their request.

Because the reconstructed flow data can not be relied upon for the entire period of record of the Wanaque Water System, a basic requirement of the safe yield estimate can not be met, that it be based on conditions analogous to a repeat of the most severe drought of record in accordance with the definition of safe yield in the Water Supply Management Act, P.L. 1981, C. 262 (N.J.S.A. 58:1A). This requirement protects the health, safety and welfare of users of the safe yield by insuring a sufficiently reliable water supply under future severe drought conditions.

It is recommended that the previously approved safe yield of 173 mgd for the Wanaque Water System be retained at this time.

If NJDWSC makes a new request for re-evaluation of the Wanaque Water System safe yield based, in part, upon the information provided by NJDWSC as a part of the current request, the following requirements should apply:

1. As a part of the request, the NJDWSC must submit to the Department of Environmental Protection for review, the raw data, daily calculations and daily natural surface water flow data for the time period from October 1, 1919 through December 31, 2003, that were used to create the daily reconstructed surface water flow data and time series inputs for all of the control points in the NJDWSC Wanaque Model. The raw data, calculations and natural flow data should be submitted in Microsoft Excel format. An explanation and justification for the methodologies used to create the

natural flow data and reconstructed flow data for the time period since October 1, 1979 must be included in the submittal.

2. As a part of the request, NJDWSC must provide the Department of Environmental Protection with a copy of the Wanaque Model that removes all instructions that cause the model to be in any way inaccessible or to be inaccessible to the Department after some date certain. The Wanaque Model must be provided to the Department in a form where it can be utilized by the Department at any time in the future.

A current estimate of the safe yield of the Wanaque Water System is needed in order to ensure a sufficiently reliable water supply from the system. As a part of the Department's Passaic-Hackensack Water Supply Project, the Department has contracted with the USGS to assist with developing a set of fully documented safe yield model input stream flows with the intention of using them in a future expanded version of the Department's draft RiverWare model to estimate the safe yields of the Wanaque Water System and other water supply systems in the Passaic and Hackensack river basins.

Richard D. Grabowski

Date: 12/30/2010

Richard D. Grabowski
Regional Water Supply Planning Section
Bureau of Water Allocation

Date: 1/3/2011

Thomas Brand P.E.
Regional Water Supply Planning Section
Bureau of Water Allocation

Date: 12/28/2010

Robert Hudgins
Northern Permitting Section
Bureau of Water Allocation

dlg 1/3/2011